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ABSTRACT

This is one of several teacher's guides for the 4M Company, a set of materials for teaching metric concepts and computation skills to elementary school students. Included in this guide are sections on needed materials, temperature, length, metric prefixes, decimals, mass, area, perimeter, and a minicourse on metrics. Answers to the activities in the related student activity manual are included. (RH)

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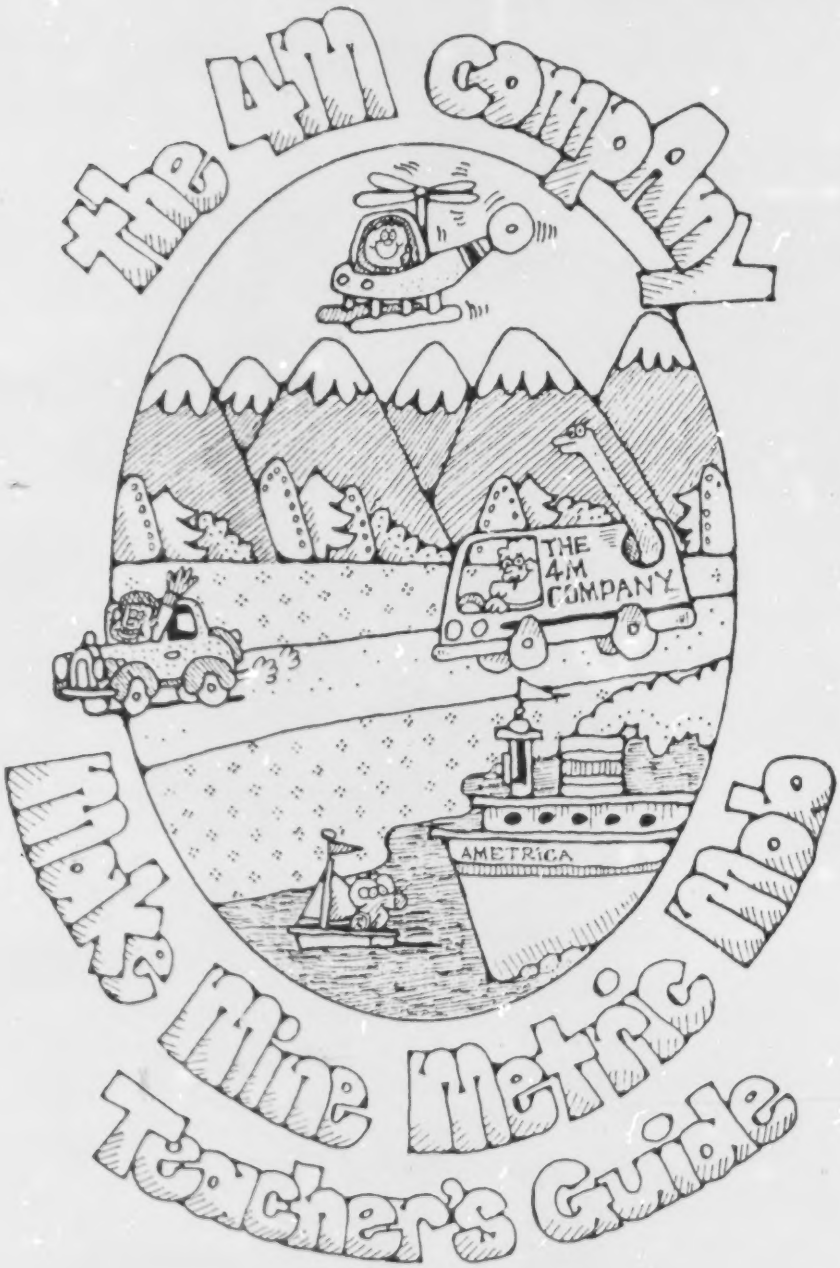

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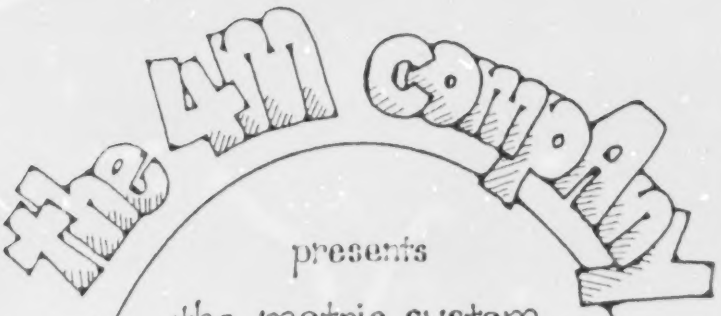

presents

the metric system

starring the

MAKE MINE METRIC MOB

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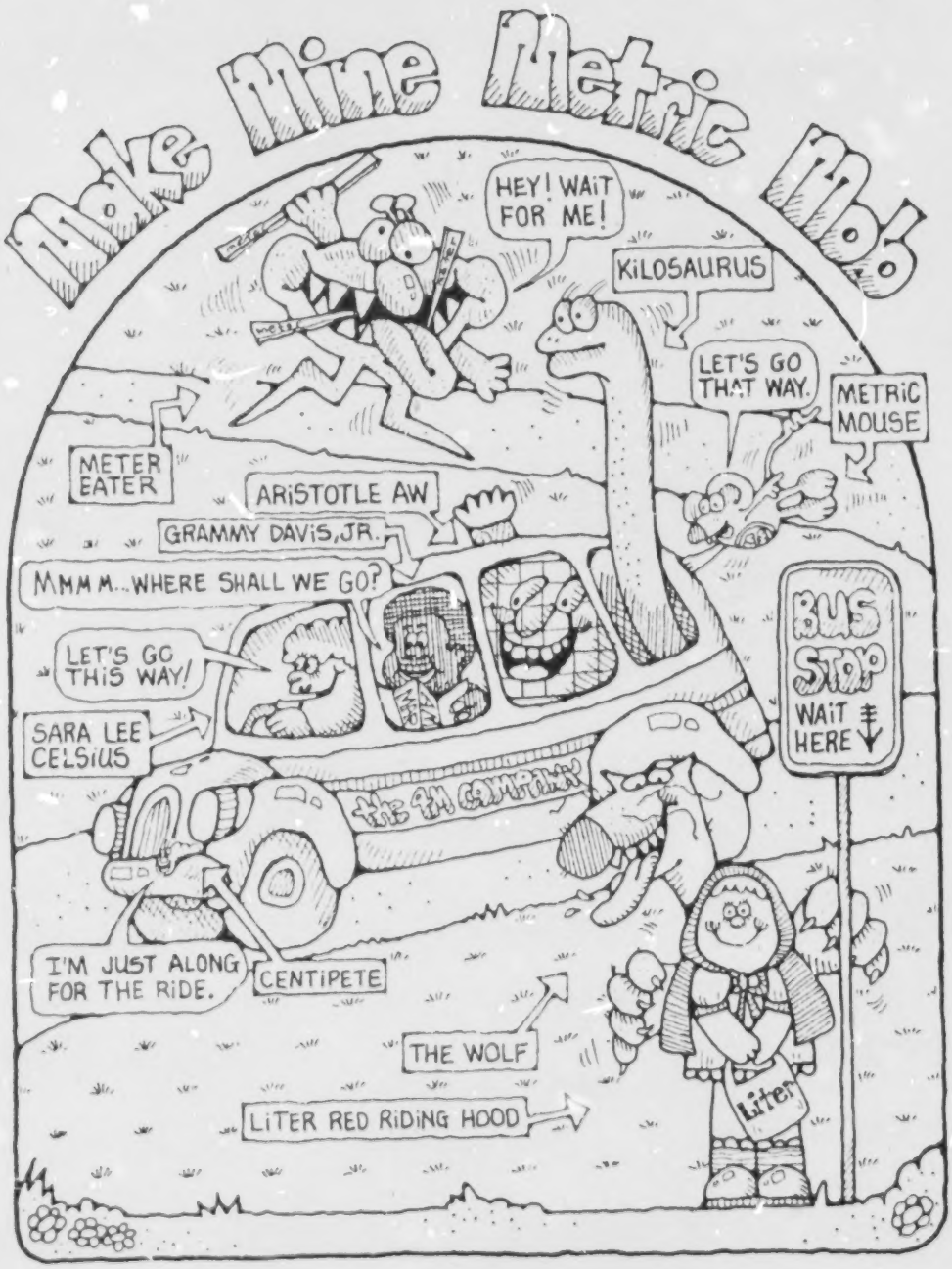
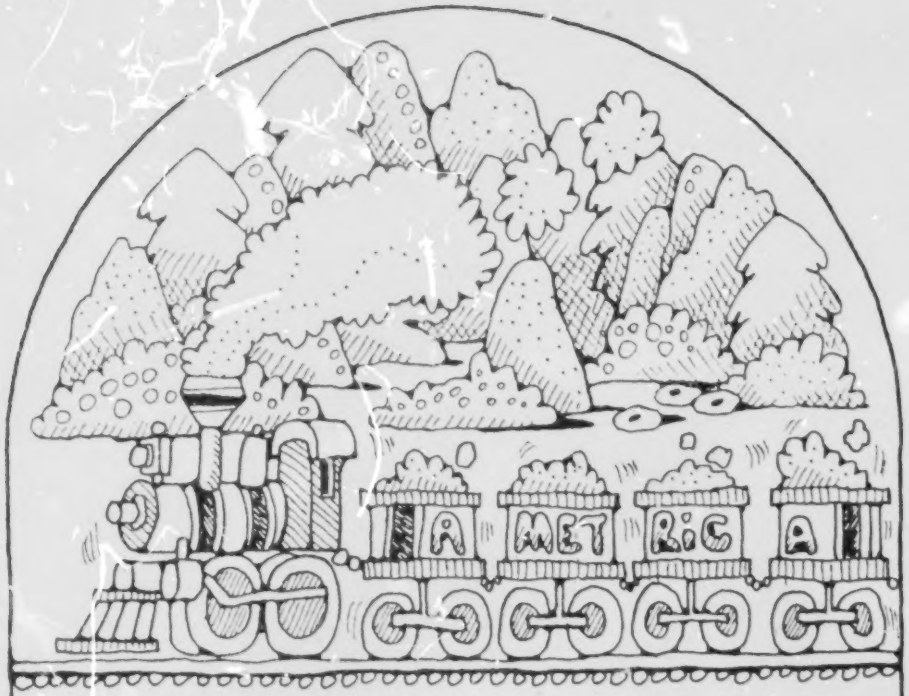

Make mine Metric Mob
HEY! WAIT FOR ME!
KILOSAURUS
LET'S GO THAT WAY.
METRIC MOUSE
METER EATER
ARISTOTLE AW
GRAMMY DAVIS, JR.
MMM M... WHERE SHALL WE GO?
LET'S GO THIS WAY!
SARA LEE CELSIUS
BUS STOP WAIT HERE
I'M JUST ALONG FOR THE RIDE.
CENTIPETE
THE WOLF
LITER RED RIDING HOOD
Liter

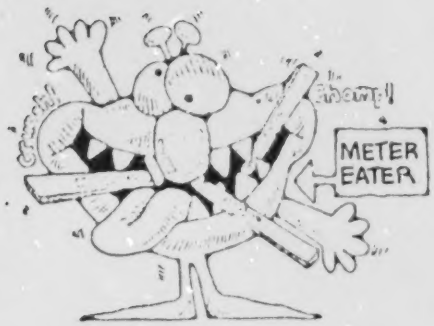


The Make Mine Metric Mob travels across Ametrica, teaching about the metric system of measurement. Members of the Mob are the fearless Meter Eater, Metric Mouse, Sara Lee Celsius, Liter Red Riding Hood and her wolf, Centipete, the Kilosaurus, Grammy Davis Jr., and Aristotle Aw. Join them as they travel the states from Kilorado to Alagrama, from New Metrico to Oregram. Pack your bags!

LET'S GO!

the 4M company

the 4th compAny



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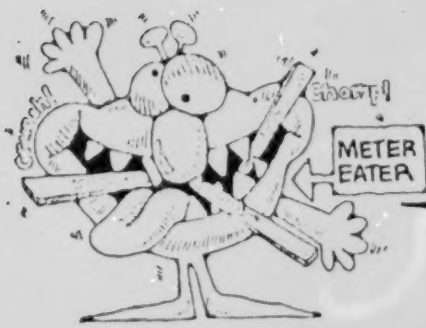
MAKE MINE METRIC MINI-COURSE

the 4M company



to the teacher... read carefully before you begin teaching

Curriculum materials are only one of the factors involved in the learning process. No program can anticipate the other factors - your unique characteristics as a teacher, the characteristics of your students, and your classroom situation. Yet these factors must all be considered for a successful learning experience. It is you, the teacher, who must analyze these factors to make decisions and adjustments in the learning activities as described in this Teacher's Guide.

The 4M COMPANY provides a variety of classroom organizations: at times students will work as an entire class, at times they will work in small groups, and at times they will work alone. Depending on the unique combination of factors which make up your classroom, the procedures recommended in this Teacher's Guide may or may not work in your particular classroom. Feel free to adapt the program to meet your particular needs. Following the Teacher's Guide word-for-word is not important; learning the objectives of the program is!

You are a unique person, and no one will teach The 4M COMPANY exactly as you do. Your strengths, your weaknesses, your abilities, and your overall philosophy will influence your teaching. Keep in mind, however, the following roles which you must play as a teacher.

The role of a planner. The 4M COMPANY is an activity program, and you will be required to prepare materials for most lessons. Things will not always work out as you had planned, so be prepared to alter your plans if the need arises.

The role of a demonstrator. Although this Teacher's Guide outlines one approach to teaching the objectives of a lesson, you must decide if a given demonstration is working with your students. They are unique, and you may have to alter the demonstrations to meet their level of understanding.

The role of a questioner. Instead of always giving answers, ask the children remedial questions that will clarify their thinking. Ask more difficult questions of children who need more challenge.

The role of a motivator. No student can be made to learn if he doesn't want to. The 4M COMPANY has tried to motivate children in several ways - the cartoon format of the booklets, the use of a story line for each grade level, and the use of games and activities. But in addition to our efforts, you will still need to motivate and encourage children to learn.

The role of a summarizer. At the conclusion of an activity, you encourage students to share their findings. It is important to summarize the results of each activity.

We have tried to make The 4M COMPANY an enjoyable and effective metric program. To a large extent your attitude will determine the success of the

program. If you are unfamiliar with parts of the metric system, admit this to yourself and to your students. If you adopt a positive attitude of learning with your students, this will do much to create a good classroom environment. For ready reference, the Appendix to this Teacher's Guide contains a brief review of the metric system.

The following paragraphs deal specifically with this level of The 4M COMPANY. Please read them carefully.

content

At this level of THE 4M COMPANY students are exposed to the following metric units: meter, decimeter, centimeter, millimeter, liter, deciliter, centiliter, milliliter, kilogram, gram, decigram, centigram, milligram, and degree Celsius. The concepts of perimeter and area are presented in terms of metric units. Decimeters and centimeters are presented as tenths and hundredths of a meter, and students measure and compute with two-place decimals. Repeated exposure to the chart of the metric units helps reinforce the structure of the metric system.

management

Management will be a key factor in the success of this program. Seatwork that reinforces metric concepts or vocabulary has been included in key places in the program to help alleviate the classroom management problems that accompany activities.

decimals

In The 4M compAny, the base ten nature of the metric system is used to introduce decimals as a natural part of measure. A decimeter is 0.1 meter and a centimeter is 0.01 meter; a deciliter is 0.1 liter and a centiliter is 0.01 liter. The emphasis is upon how to measure, read and write decimal expressions. A complete understanding of place value is not expected at this level. Such an understanding will develop through several years of repeated exposure to and practice with decimal notation. The goal of the overall program is to generalize the idea of a decimal fraction in the last level, when children are more prepared for understanding.

zero

In writing decimal expressions less than 1.0, it is now recommended that a zero be placed in the one's place. For example, 0.3 meters is recommended instead of .3 meters. This convention is practiced worldwide. The use of the zero has two main advantages: 1) If the decimal point is light, or somehow erased, it is immediately evident that the point is missing. For example, 03 means three tenths, or 0.3; 2) In teaching small children it helps us distinguish the fractional parts from the whole parts. For example, in the expression .27, some children might think that the 7 is in the ones place and the 2 in the ten's place. By placing a zero in the one's place this confusion might be avoided.

estimating

Throughout the program children should be encouraged to estimate before measuring. Encourage careful measuring, but explain that no measure is exact. Use the words "about" or "almost" to describe inexact measurements. This is the initial step in understanding how to round off to the nearest whole unit.

reinforcement

Experience has shown that retention of metric concepts and vocabulary will occur only if they are reinforced throughout the school year. Make a flashcard for each metric unit and another for its symbol. Use these frequently to reinforce metric vocabulary. It is also a good idea to set metric units in front of the class and have them identify the various units by name. Familiarity with the units is a major goal of the program, and this can be achieved by frequent drill and review.

computation

In this program addition and subtraction appear as applications of measurement. It is expected that these concepts will be taught in the regular math program. The work in this program will reinforce these concepts and skills. Because we do not want the lack of computational skill to interfere with a student's success in measurement, the addition and subtraction problems may appear to be somewhat easy for better students.

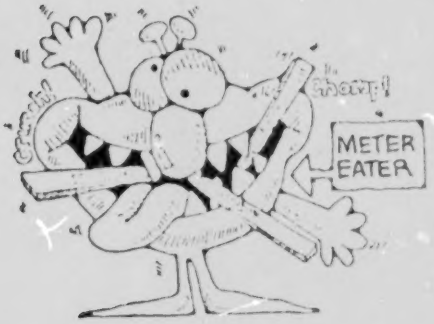
rounding off

Measurement provides an easy, visual model for teaching students how to round off: the measurement is rounded off to the nearest unit by merely looking at the measuring instrument. It is not until later that students will be taught how to round off written expressions. At this time rounding should be kept at an informal, contrete level.

metric chart

It is recommended that each classroom have a chart of the metric system. Put one up early in the year and as each metric unit is introduced, point it out on the chart. Page 69 in this Teacher's Guide maybe used to make a colorful poster where each unit can be highlighted with color when it is introduced. The page may be removed, used to make an overhead transparency, and the overhead projector used to enlarge the chart onto a piece of poster board where it can be traced and colored. An opaque projector may be used to accomplish the same thing using the page directly.

the 4M company



Materials

section number	materials description
1	Celsius thermometers, glass of warm water, glass of ice cubes, bowl of ice cubes
2	meter sticks; adding machine tape; centimeter rulers (Each child should have a ruler. Those available in local stores are fine as long as one scale is metric.); dm and cm models, if available (Metric sized place value blocks and rods are ideal.); decimeter strips cut from page 53 of Teacher's Guide (one per student)
3	rulers with mm markings, a dime, meter, decimeter, centimeter, 10 student meter strips
4	adding machine tape, students' meter strips from Section 2, tape or thumb tacks, 15 dm strips cut from page 55 of the Teacher's Guide, several blank meter strips cut from adding machine tape, a "tenths ruler" 4 meters long made from adding machine tape (activity #10)
5	meter and dm strips, 4 m long tenths ruler from Section 4
6	unmarked meter strip, cm ruler, meter strip marked in cm and labeled in hundredths of a meter prepared from page 57 of the Teacher's Guide or from adding machine tape, dm and cm units (metric-sized place value blocks and rods or dm and cm strips cut from page 55), meter marked in tenths (from Section 4), meter stick, several meter strips or sticks, hundredths ruler 4 meters long prepared from pages 59 to 63 of the Teacher's Guide
7	meter numbered in hundredths (from Section 6), meter strips or sticks, dm and cm units (from Section 6)
8	meter numbered in hundredths, meter strips or sticks, dm and cm units
9	2 large containers to measure in liters, liter measures; for page 39 a liter, dℓ, and cℓ measure; for page 40 an empty soda can, an empty 8-oz. milk carton (lunch milk size), a paper cup, a dℓ measure; for the Taste Test 1 quart bottle of Mailolo syrup (or similar fruit punch syrup concentrate), three pitchers or liter containers, small tasting cups (3 per student -- 1/2 oz. paper portion containers are suggested), paper cups (1 per student), dℓ measure, cℓ measure; for the game a variety of jars and bottles, 2 small identical clear jars with marks at the 1 dℓ level
10	liter measure, dℓ measure, cℓ measure, mℓ measure (cut from page 65 of the Teacher's Guide), 100 mℓ graduated cylinder (see your science department), 2 containers to be measured in mℓ (labeled J and K), aquarium and large bucket or tub (optional), 12 meter sticks, tape
11	liter measures, dℓ measures (3 1/2 oz. plastic Solo cups hold 1 dℓ), soda can, 8 oz. milk carton, and paper cup from Section 9

section number	materials description
12	liter, deciliter, and centiliter measures (3 1/2 oz. plastic Solo cups hold 1 dℓ and small paper portion control cups can be marked to show 1 cℓ)
13	one-gram weights, balance (optional), pull-type spring scale calibrated in grams and a mesh bag (or a platform scale), stapler, book, unopened can of soup, vitamin bottle or ceral box with milligrams printed on the label, kilogram weight, kilogram bathroom scale
14	cm rulers
15	the following shapes cut from different colored paper: 2 squares (10 cm x 10 cm), 1 square (15 cm x 15 cm), 1 circle (radius 7.5 cm), 1 rectangle (5 cm x 20 cm) (Patterns for these appear on page 67 of the Teacher's Guide.)

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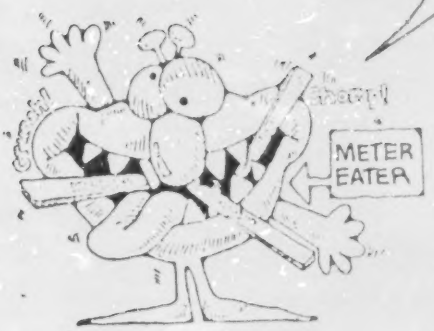
section 1 · temperature



Objectives: Given a Celsius thermometer, read the temperature to the nearest degree.

Given an illustration of a thermometer, read the temperature to the nearest degree.

Given an illustration of a thermometer, shade it to show a specified temperature.

Recall that water boils at 100°C and freezes at 0°C.

Materials: Celsius thermometers, glass of warm water, glass of ice cubes, bowl of ice cubes

Vocabulary: temperature, degree Celsius, °C, thermometer, boiling, freezing

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Use a glass of ice cubes and a glass of warm water to illustrate how temperature affects the red fluid in a thermometer. Point out the following features:
   a. The top of the red liquid tells us the temperature.
   b. The numbers tell us the number of degrees.
   c. The symbol ° is read "degrees".
   d. As temperature rises, the red liquid rises.
   e. As temperature falls, the red liquid falls.
   f. If you touch the glass with your hand, it will affect the temperature. So handle the thermometer by its frame.

2. Turn to page 1 of the Student Booklet. Review counting by tens. Then discuss what the marks between the multiples of 10 mean on the thermometers. Read the first and third thermometers together, recording the temperature in the boxes below. Then assign pages 1 and 2.

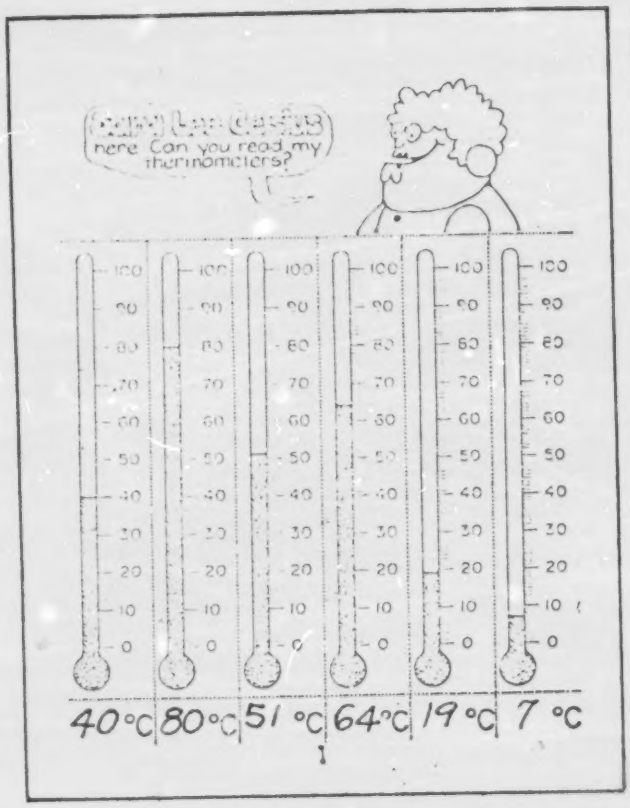
3. For page 3, have the students shade the thermometers to show the given temperature.

4. Page 4 is for recording the results of an activity. Set up one thermometer in a glass of ice cubes and water, one lying in the sun, and one which can be held in the students' hands. They are to read the thermometers, record the temperatures on page 4, and shade the thermometers to show their findings.

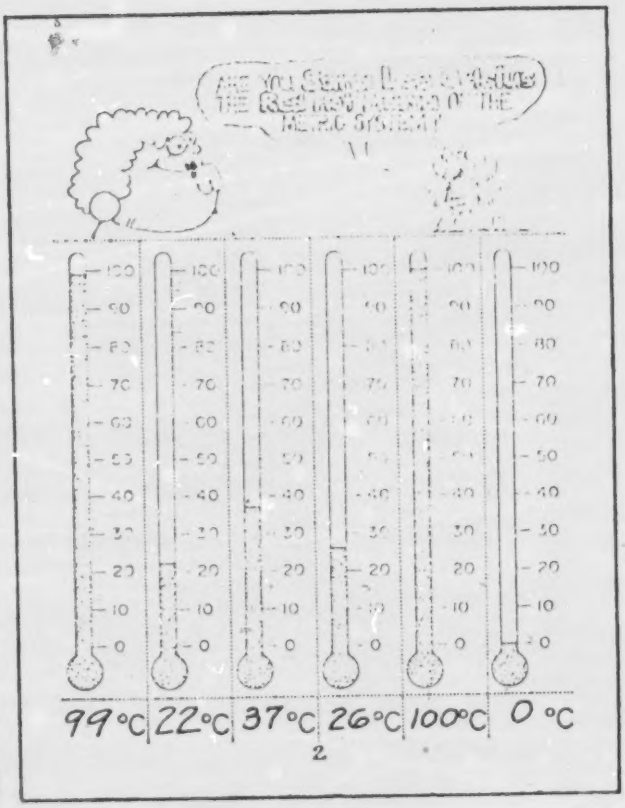
5. Discuss the results from page 4. See how cold the ice water became. Point out that water freezes at 0° C and boils at 100° C. Normal body temperature is 37° C, but the student's results may be several degrees lower. Leave one thermometer in the room and have a student read the temperature. Discuss the meaning of "room temperature" as being the temperature of the air in the room.

6. Play a verbal game to help students remember that water freezes at 0° C and boils at 100° C. Call out an item and have the class respond with either "0° Celsius" or "100° Celsius". Suggested items might be: "Is ice cream closer to 0° C or 100° C? Snow? Hot coffee? A freezer? Baking a cake? Fire?"

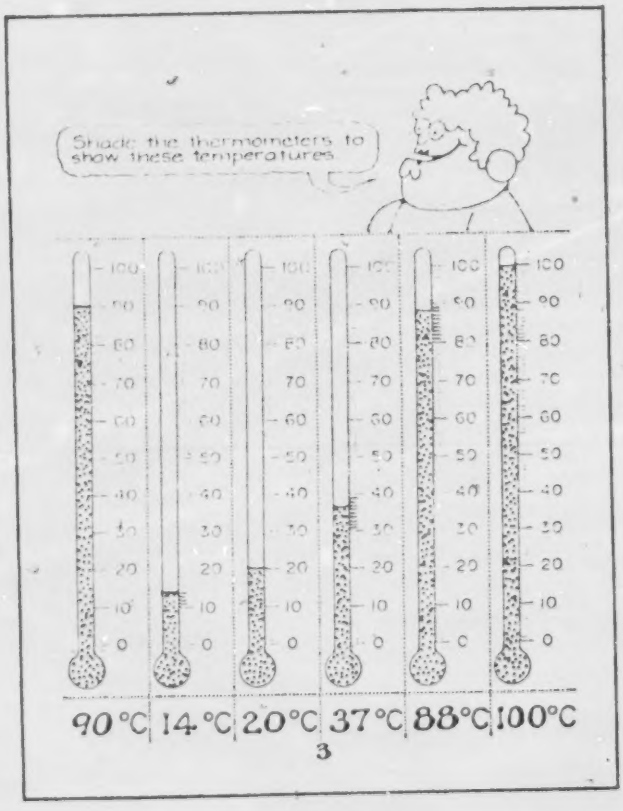
7. Set out a bowl of ice cubes and measure its temperature at frequent intervals. Record these intervals on the chalkboard. See if you can get a reading at 0° C. Keep the thermometer in the water for several hours. Notice that the temperature of the water gets closer and closer to room temperature as time passes.


Hello! Look closely here. Can you read my thermometers?
40 °C 80 °C 51 °C 64 °C 19 °C 7 °C

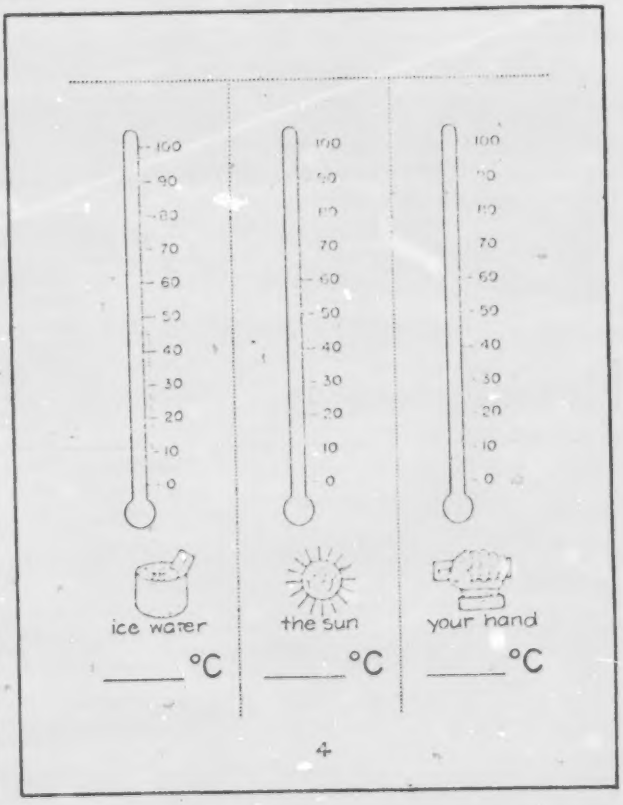
1


99 °C 22 °C 37 °C 26 °C 100 °C 0 °C

2


Shade the thermometers to show these temperatures.
90 °C 14 °C 20 °C 37 °C 88 °C 100 °C

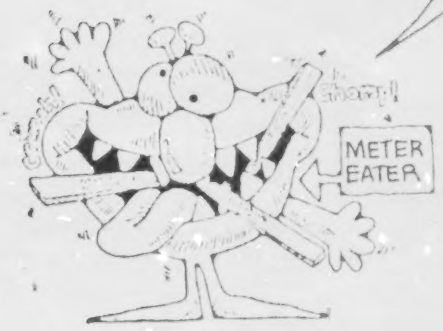
3


ice water
_____ °C
the sun
_____ °C
your hand
_____ °C

4

the 4th company

section 2 · length: meter · decimeter · centimeter



Objectives: Given a meter stick, determine the length of an object to the nearest meter.

Given a decimeter ruler, determine the length of an object to the nearest decimeter.

Given a centimeter ruler, determine the length of an object to the nearest centimeter.

Spell the metric units "meter", "decimeter", and "centimeter".

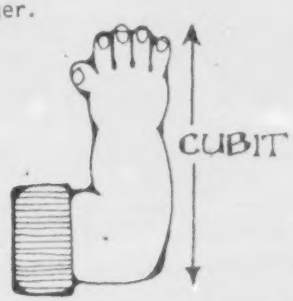
Materials: meter sticks; adding machine tape; centimeter rulers (Each child should have a ruler. Those available in local stores are fine as long as one scale is metric.); dm and cm models, if available (Metric sized place value blocks and rods are ideal.); decimeter strips cut from page 53 of Teacher's Guide (one per student)

Vocabulary: cubit, muku, anana, iwilei, meter, decimeter, centimeter, m, dm, cm

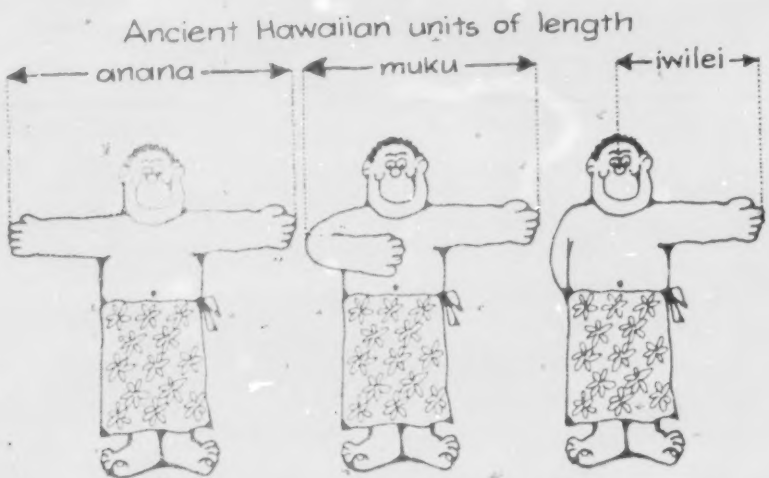
SUGGESTED PROCEDURES AND ACTIVITIES:

1. This is for review. In early history parts of the body were used to measure. Discuss the following arbitrary units with the class.

   The cubit was a unit of length mentioned in the Bible: The distance from a man's elbow to the tip of his finger.



The ancient Hawaiians had 3 units of length. Explain them to the class, then ask, "Why do you think parts of the body are no longer used for measuring?" Then select a large student and a small student. Let each measure the length of the room in ananas. Write each measurement on the board. The numbers will be different, illustrating the need for a "standard" unit for measuring length.



8

2. METER. Hold up meter stick and explain that it is the basic unit of length in the metric system. It is used by nearly all people on earth. Write "meter" and its symbol "m" on the board. Have students close their eyes and spell it out loud. Have students write the word and its symbol four times in their notebooks.

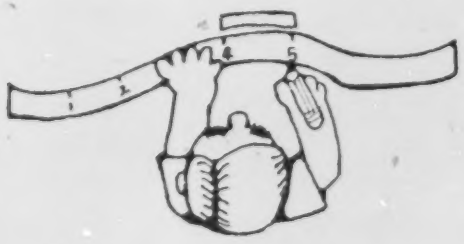
3. Tape a meter stick to a wall and let students stand next to it to see how high it comes on their bodies.

4. Provide each student with a meter strip. Adding machine tape works just fine. If students write their names on their meters they can fold them up, put them in their books, and use them whenever needed.

5. Lay two strips of masking tape on the floor. Mark one A and the other B. Using a meter, measure the length of tape A to demonstrate how to measure. Emphasize that each measurement consists of two parts: the number and the unit. Then let students take turns measuring tape B. Record findings on page 5.

6. DECIMETER. Hold up a decimeter and see if anyone can remember its name. Write decimeter and dm on the board and have students practice writing the word and its symbol. Demonstrate that 10 dm make one meter. "Deci" means "one-tenth".

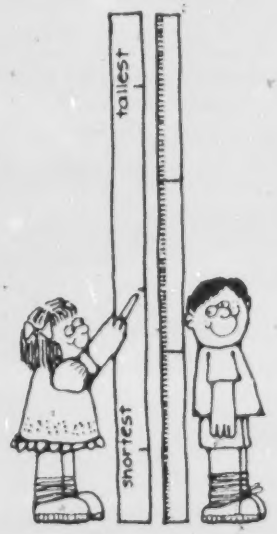
7. Make enough decimeter strips (see page 53 of the Teacher's Guide) for each student to have one. Have each student use the decimeter strip to calibrate his meter strip in decimeters. Collect the strips for later use. Draw two lines (labeled X and Y) on the board between 1 and 10 dm in length. Let students measure them with their decimeter rulers and record their results on page 5. Have them save these meter strips for later use.



8. CENTIMETER. Hold up an object which is smaller than a decimeter (a short pencil will do) and ask someone to measure it in dm. Since the decimeter is too long, this will demonstrate the need for a smaller unit. See if anyone remembers the centimeter. Point out that there are 10 centimeters in a decimeter, and 100 centimeters in a meter. "Deci" means tenth, and "centi" means hundredth, etc. If available, models of a meter, decimeter, and centimeter are ideal for demonstrating these relationships. Write centimeter and its symbol cm on the board. Have students practice writing "centimeter".

9. Demonstrate how to measure with a centimeter ruler, then assign the bottom of page 5 and page 6. Each child should have his own centimeter ruler.

10. The tallest person whose height was ever recorded stood 272 cm tall. The shortest was 59 cm tall. Tape three meter sticks end to end up a wall and tape a strip of adding machine tape beside it. Have two students mark and label the heights of the tallest and shortest humans. Then, working in pairs, let students mark and label their heights on the adding machine tape. (For further information on the tallest and shortest humans see the Guiness Book of Records)



11. Write the units meter, decimeter, and centimeter on the board. Then, one at a time, write names of objects on the board and ask the students to identify the most appropriate unit for measuring

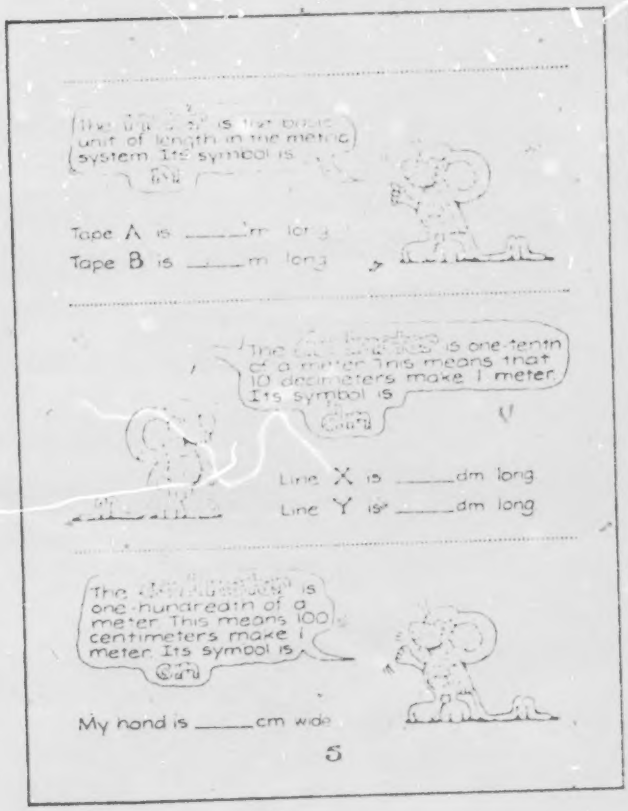
it. (Point out that the decimeter is not used very often, although we could use it if we wanted to.) "If you were going to measure the length of a bus, would you use meters, decimeters, or centimeters?"

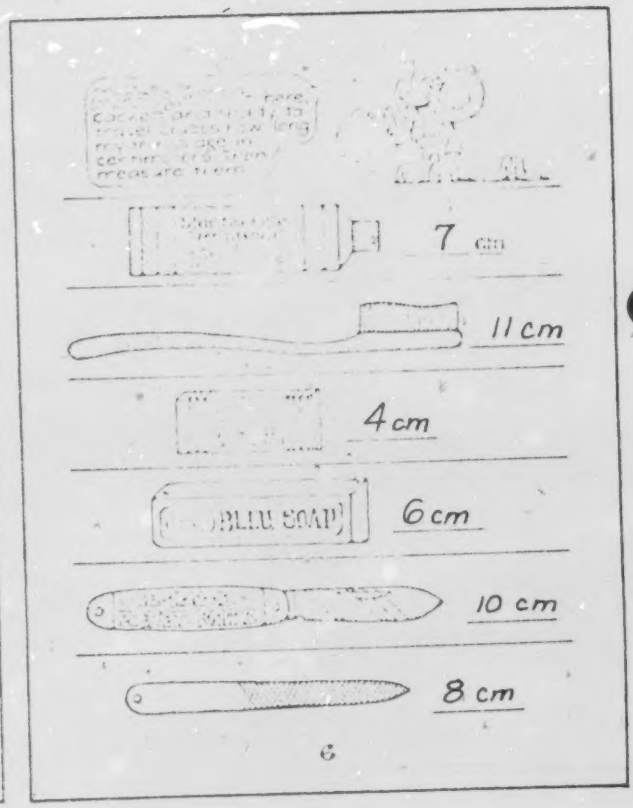
Suggested objects:

Meter - bus, car, football field, tennis court.

Centimeters - pencil, height of man, book, your waist.

12. Give a short spelling test on the metric units "meter", "decimeter", and "centimeter".


unit of length in the metric system. Its symbol is
Tape A is ____m long
Tape B is ____m long
is one-tenth of a meter. This means that 10 decimeters make 1 meter. Its symbol is
Line X is ____dm long
Line Y is ____dm long
is one-hundredth of a meter. This means 100 centimeters make 1 meter. Its symbol is
My hand is ____cm wide
5



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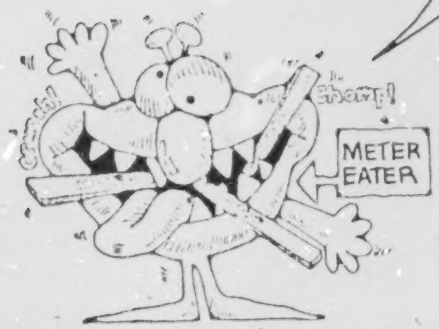
section 3 · metric prefixes



Objectives: none (see statement of purpose below)

Materials: rulers with mm markings, a dime, meter, decimeter, centimeter, 10 student meter strips

Vocabulary: millimeter, dekameter, hectometer, kilometer

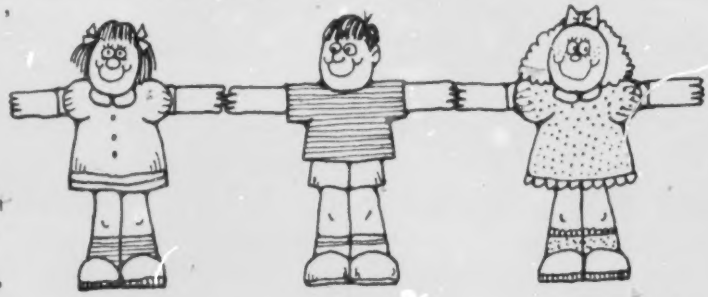
SUGGESTED PROCEDURE AND ACTIVITIES:

The purpose of this section is to introduce all six metric prefixes in a systematic manner. Students will formally encounter the millimeter, dekameter, hectometer, and kilometer for the first time. Introductory. Mastery not expected.

1. Hold up a meter. Point out that it is divided into 10 equal parts called decimeters. Point out that the decimeter is divided into 10 equal parts called centimeters. "For measuring very small things, the centimeter is also divided into 10 equal parts. Each part is called a millimeter." Let students examine a ruler with millimeter marks and have them verify that there are 10 mm in one cm. Show that a dime is about 1 mm thick. Discuss the millimeter and have students measure the lengths of several small things, like a paper clip or Metric Mouse's nose, etc. Expect some measurement error and use this as an opportunity to discuss the difficulty of precise measurement, i.e., it is difficult to be accurate when using very small units. Extreme care needs to be taken when measuring with with millimeters.

2. Discuss the metric prefixes on page 7. Deci, centi, and milli are smaller than the meter. Explain that for measuring distances greater than a meter, other prefixes were invented. Deka means 10, hecto means 100, and kilo means 1000. Explain that "kilo" always means 1000, "hecto" always means 100, etc. Let children use the chart to answer such questions as, "How much is a dekameter?" Answer: 10 meters.

   Then reverse it. Ask, "What is another name for 100 meters?" Then have the students complete the chart at the bottom of the page. Discuss the symbol for each unit. Since "deci" and "deka" both begin with the letter "d", be sure to point out that "da" stands for deka. To see how long a dekameter is have ten students place their meter strips end-to-end. Have one student stand with his arms out-stretched. Have the class guess how many students, placed finger-tip-to-finger-tip, it would take to make a dekameter. Then verify.

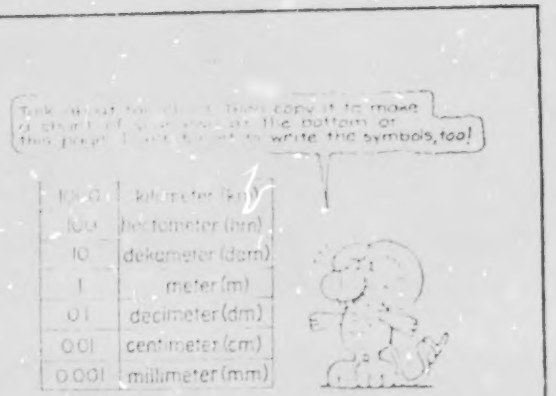


3. Explain that a hectometer is a little

longer than a football field. If a field is available, let the class walk from one end to the other to get a feel for a hectometer. With one end zone added, the distance is about one hectometer.

4. Explain that the kilometer is used for long distances, such as when driving a car or flying a plane. Assign page 8. This is a simple exercise in reading metric distances from a map. Have a discussion about flying to these islands.

5. Assign page 9. After completing the page, ask the class if they know what "meople" means. (It means "mouse people".)



1000	kilometer	(km)
100	hectometer	(hm)
10	dekameter	(dam)
1	meter	(m)
0.1	decimeter	(dm)
0.01	centimeter	(cm)
0.001	millimeter	(mm)

7

How far is it (km)...

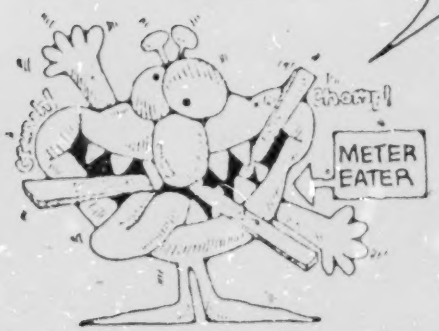
Kaua to Oahu? 163 km
Hilo to Maui? 194 km
Lanai to Maui? 54 km
Oahu to Kona? 272 km
Maui to Molokai? 77 km

8

9

the 4th company

section 4 · decimals: tenths of meters



Objectives: Given a meter marked in tenths, measure and record lengths correct to the nearest tenth of a meter.

Given meter and decimeter strips, write the corresponding decimal.

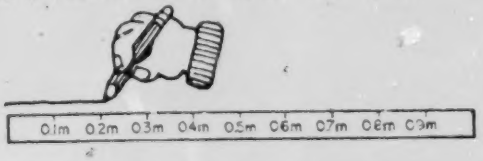
Materials: adding machine tape, students' meter strips from Section 2, tape or thumb tacks, 15 dm strips cut from page 55 of the Teacher's Guide, several blank meter strips cut from adding machine tape, a "tenths ruler" 4 meters long made from adding machine tape (activity #10)

Vocabulary: tenths of a meter "___ point ___ meters", decimal

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Cut a strip of adding machine tape one meter long. Mark each dm and number it clearly from 1 through 9 only. Tape it on the chalkboard. Ask the class how many meters long it is, then how many decimeters long it is. Review that since 10 dm = 1 m, each dm is one-tenth of a meter. Write it in two ways on the board: 1/10 m and 0.1 m. Explain that in the metric system we use the decimal form. Read 0.1 m two ways for the class: "one-tenth of a meter" and "zero point one meters". Ask if anyone thinks he can write the decimal for 2 dm, that is "two-tenths of a meter". Have the class read 0.2 m both ways ("two-tenths of a meter" and "zero point two meters"). Ask someone to write three-tenths, four-tenths, etc. Then renumber <u>your</u> meter strip in tenths, adding a zero, a decimal point, and an "m" for meter to each number 0.1 m through 0.9 m only. Have the class read each one as you rewrite it. Explain that you have just relabeled the decimeters as tenths of a meter.

2. Have students turn to page 10. On the chalkboard draw a line 0.2 m long above the strip. Explain, "This line is two-tenths of a meter long. We write this as ..." Write 0.2 m on the board. Draw a line 0.4 m long above the meter and have students write its length on page 10. Erase, then repeat seven times with the following lengths: 0.9 m, 0.1 m, 0.6 m, 0.7 m, 0.5 m, 0.3 m, 0.0 m. The last one, of course, is no line at all. Check answers. Remind the students to write an "m" for meter each time.



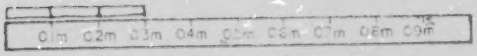
3. Do page 11 together. Read off five decimals and have students draw lines on page 11 to represent these lengths. 0.7 m, 0.6 m, 0.3 m, 0.1 m, 1.0 m. The last one is one meter long. Explain that the pictures in their books are much smaller than a real meter, but that they are to draw lines to show what it would like drawn on the board. When completed, draw lines on the board to illustrate each problem.

4. Ask students to take out their own meter strips (saved from Section 2, Part 7) and relabel the dm as you had done with the one on the board. They need to add zeros, decimal points, and "m's" to convert their dm rulers to "tenths" rulers. They should look like the one on the board. (Be prepared to replace

lost and torn strips.)

5. Assign page 12. Students are to measure various lengths and record them to the nearest tenth of a meter. They should use their newly converted "tenths" rulers.

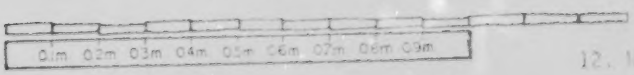
6. Use thumb tacks or tape to fix a meter marked in tenths to a bulletin board or chalkboard. Hold up three dm strips. Explain "Each of these strips is one dm long. If I placed them end-to-end, how long would they be?" Then tack or tape them above the meter strip to show that 3 dm placed end-to-end are three-tenths of a meter long. Let a volunteer write 0.3 m on the board.



Have each student take out a sheet of paper and number it from 1 to 5. Hold up five dm strips and ask how long they would be placed end-to-end. Have the students write that length in tenths of meters on their papers. Check answers, correct errors, line the dm strips against the meter strip if necessary. Do five problems in all: 0.5 m, 0.9 m, 0.1 m, 0.8 m, 0.4 m.

7. Assign pages 13 and 14. Students are to write the decimals for the lengths represented.

8. To introduce decimals for lengths of 1 m or longer, use the meter strip marked in tenths attached to the bulletin or chalkboard, dm strips, and meter strips. Hold up thirteen dm strips and say, "Let's see how long thirteen dm strips would be placed end-to-end." Tack or tape them along the meter strip.



Explain that since 10 dm = 1 m, we have 1 meter and three-tenths of a meter more. Write 1.3 m on the board. Explain that the "1" tells us how many whole meters we have, and the "3" tells us how many tenths of a meter we have. So 1.3 m is three-tenths of a meter longer than 1 meter. Write 1.6 m on the board. Explain, "one and six-tenths of a meter is six tenths of a meter longer than 1 meter." Hold up one meter strip and six dm strips. Write 1.3 m and ask someone to show what it is with meter and dm strips. Write 2.1 m and ask if anyone can show it. Repeat with several more examples. Finally write 1.0 m and ask, "What would one and zero tenths meters look like?" Explain that 1 m and 1.0 m are the same.

9. Have students turn to page 15. Hold up 1 meter and 2 dm strips and ask, "How would I write this length as a decimal?" Write 1.2 m on the board. Complete page 15 with the following: 2.1 m, 3.4 m, 0.3 m, 0.9 m, 2.0 m, 1.9 m, 4.0 m, 1.5 m, 4.3 m.

10. Make a tenths ruler 4 meters long from adding machine tape. Mark each decimeter, and label it 0.1 m, 0.2 m, ..., 3.9 m. Attach it to a wall or chalkboard. Have the class read the entire ruler: "one-tenth, two-tenths, three-tenths, ..., three and nine-tenths, four meters." Do the following activities using this number line.

   a. Call out a point between 0.1 m and 4.0 m and have a student come forward and locate it. Go around the room and see how fast students can locate their points.
   b. Call out and/or write two different lengths and ask which is longer.
   c. Call out and/or write two different lengths and ask for a length in between them.

   Save this line for use later on. Be sure to point out that the numbers, without the decimal points, are merely consecutive integers: 01, 02, 03, ..., 38, 39, 40. This is an easy way for them to remember the sequence of tenths.

11. Assign page 16 to provide practice with the numeration of decimal numbers.

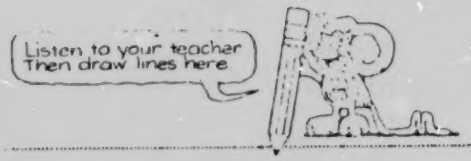
12. Write 3.7 on the board. Ask the students what comes next. Repeat with the following: 4.9, 21.3, 29.9, 6.2, 9.1. Do others if necessary.

Listen to your teacher Write the correct decimals here.

0.1m 0.2m 0.3m 0.4m 0.5m 0.6m 0.7m 0.8m 0.9m

1. 0.4m
2. 0.9m
3. 0.1m
4. 0.6m
5. 0.7m
6. 0.5m
7. 0.3m
8. 0.0m

10



Listen to your teacher Then draw lines here

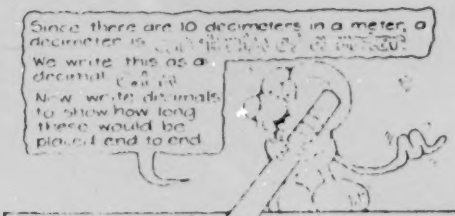
1. (0.7m) 0.1m 0.2m 0.3m 0.4m 0.5m 0.6m 0.7m 0.8m 0.9m
2. (0.6m) 0.1m 0.2m 0.3m 0.4m 0.5m 0.6m 0.7m 0.8m 0.9m
3. (0.3m) 0.1m 0.2m 0.3m 0.4m 0.5m 0.6m 0.7m 0.8m 0.9m
4. (0.1m) 0.1m 0.2m 0.3m 0.4m 0.5m 0.6m 0.7m 0.8m 0.9m
5. (1.0m) 0.1m 0.2m 0.3m 0.4m 0.5m 0.6m 0.7m 0.8m 0.9m

11

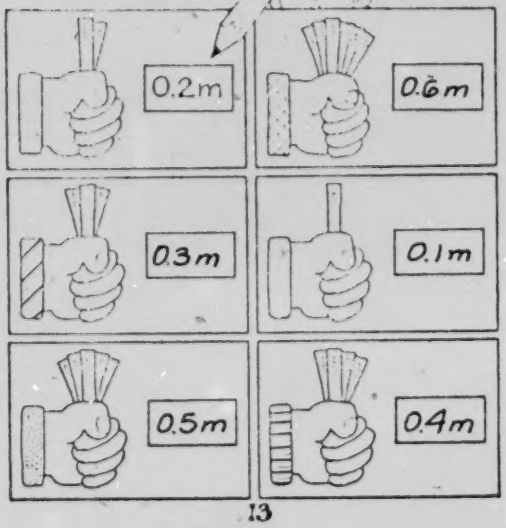
Make these measurements as a group. Write them in metres

length of my desk _____
width of my desk _____
length of my metric booklet _____
width of my metric booklet _____
my waist _____
length of my foot _____

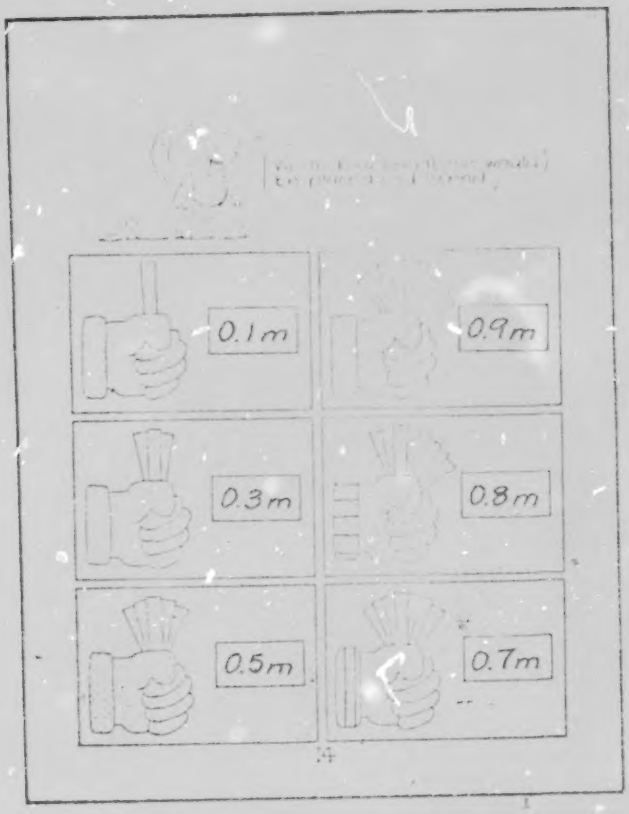
12

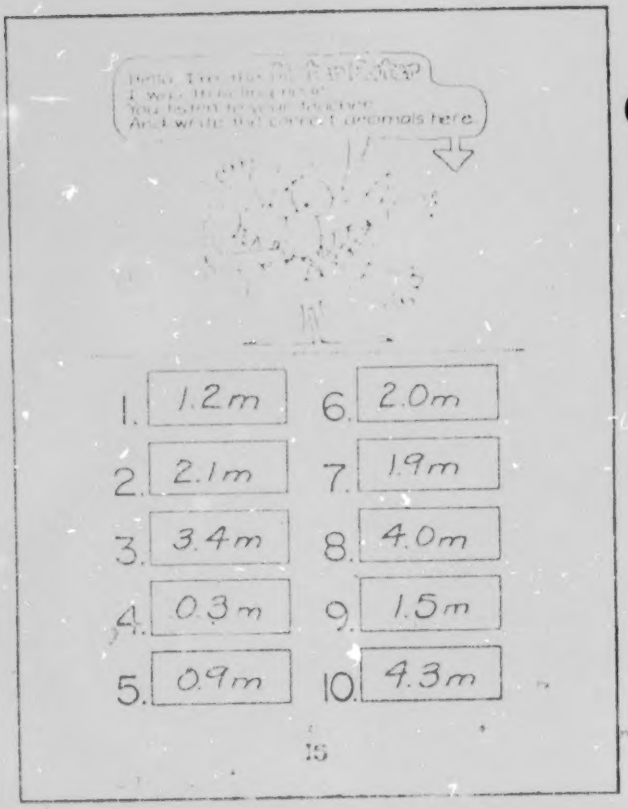


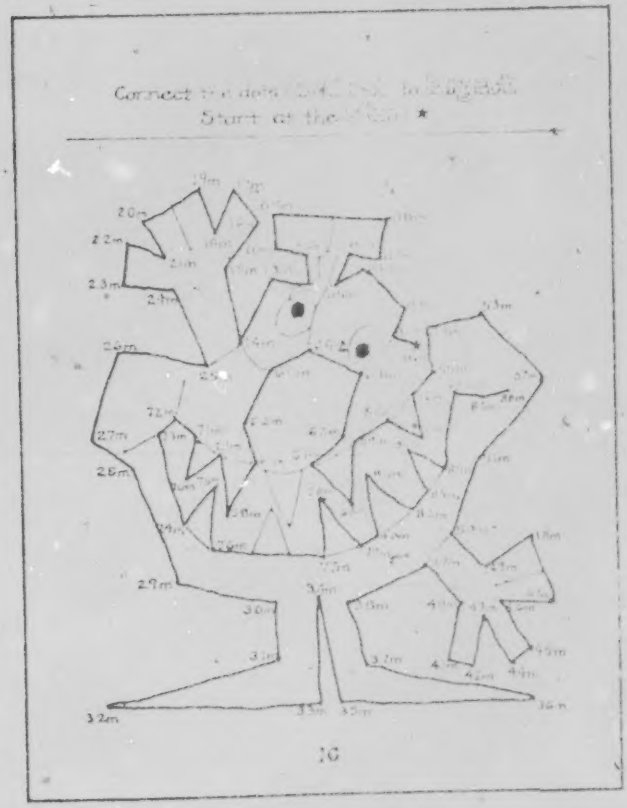
Since there are 10 decimeters in a meter, a decimeter is [illegible]
We write this as a decimal. Call it
Now write decimals to show how long these would be placed end to end



13


0.1m
0.9m
0.3m
0.8m
0.5m
0.7m


1. 1.2m
2. 2.1m
3. 3.4m
4. 0.3m
5. 0.9m
6. 2.0m
7. 1.9m
8. 4.0m
9. 1.5m
10. 4.3m



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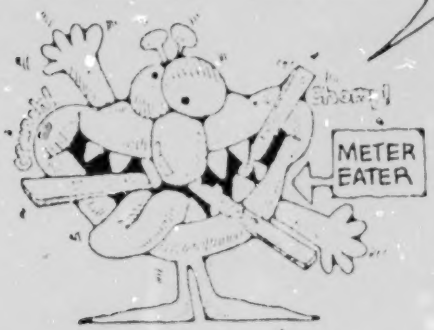
section 5 · decimals: add and subtract tenths of meters



Objectives: Given two expressions involving tenths of meters, find their sum.

Given two expressions involving tenths of meters, find their difference.

Materials: meter and dm strips, 4 m long tenths ruler from Section 4

Vocabulary: tenths of a meter, "___ point ___ meters", decimal

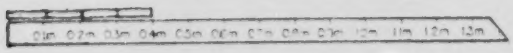
SUGGESTED PROCEDURES AND ACTIVITIES:

Tape or tack the 4 m long tenths ruler (from Section 4, Activity #10) to a wall or board. Illustrate addition and subtraction of tenths by taping or tacking meter and dm strips above it according to the following suggested procedures.

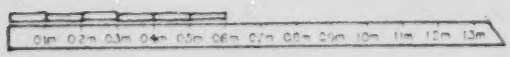
1. Ask, "How long is four-tenths of a meter plus two-tenths of a meter?" Write on the board:

$$\begin{array}{r} 0.4\,m \\ +\ 0.2\,m \\ \hline \end{array}$$

Tape 4 dm strips along the 4-meter strip.



Explain that you have four-tenths of a meter and will add two-tenths to it. Tape up 2 more dm strips.



Read the answer from the 4-meter strip and write it on the board.

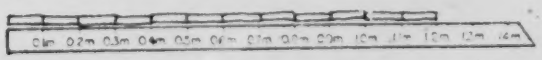
$$\begin{array}{r} 0.4\,m \\ +\ 0.2\,m \\ \hline 0.6\,m \end{array}$$

Write another problem on the board (sum less than 1.0 m) and ask the class to work it. Illustrate it with dm strips to verify the answers. Do a few more examples and explain that adding decimals is just like adding regular numbers, except we bring the decimal point straight down in the answer. And when we add tenths of meters we must label our answer as meters.

2. Illustrate a sum greater than 1.0 m. Write this problem on the board.

$$\begin{array}{r} 0.7\,m \\ +\ 0.5\,m \\ \hline \end{array}$$

Ask the class to think about what the answer should be while you tape 7 dm strips above the 4-meter strip. Tape up 5 more dm and read the answer from the strip.



Write the answer.

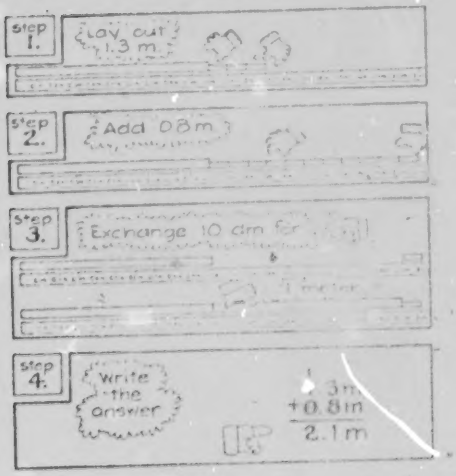
$$\begin{array}{r} 0.7\text{m} \\ +\ 0.5\text{m} \\ \hline 1.2\text{m} \end{array}$$

Point out that the 1 means one whole meter and the 2 means two-tenths of a meter more. Refer to the dm strips on the board to verify that 12 dm strips are indeed 1.2 m. Tape a 1 meter strip over the first 10 dm to emphasize the exchange of 10 dm for 1 meter. Explain again that adding decimals is like adding regular numbers, except we bring the decimal point straight down. "Seven plus five is twelve; bring down the decimal point to make 1.2 meters."

3. Explain the first example of page 17. Then assign pages 17 and 18.

4. Page 19 involves carrying. Before assigning the page, illustrate carrying with a problem like the following:

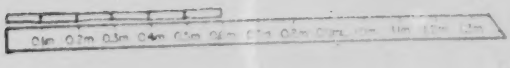
to add: $\begin{array}{r} 1.3\text{m} \\ +\ 0.8\text{m} \\ \hline \end{array}$



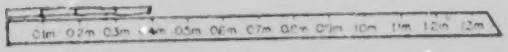
5. Ask, "If I had six-tenths of a meter and took away two-tenths of a meter, how much would I have left?" Write on the board:

$$\begin{array}{r} 0.6\text{m} \\ -\ 0.2\text{m} \\ \hline \end{array}$$

Tape 6 dm strips above the 4-meter strip.



Explain that you have six-tenths of a meter and will subtract two-tenths from it. Take away two dm strips and read the answer.



Write it on the board.

$$\begin{array}{r} 0.6\text{m} \\ -\ 0.2\text{m} \\ \hline 0.4\text{m} \end{array}$$

Write another simple problem on the board and ask the class to work it. Illustrate it if necessary. Explain that subtracting decimals is just like subtracting regular numbers, except we bring the decimal point straight down in the answer. Write this problem on the board.

$$\begin{array}{r} 2.5\text{m} \\ -\ 1.2\text{m} \\ \hline \end{array}$$

Ask the class for the answer. Remind them to ignore the decimal point to subtract, then put the decimal point back in the answer. Explain, "5 minus 2 is 3. 2 minus 1 is 1. Now bring the decimal point straight down in the answer and label it with 'm' for meters."

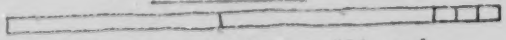
$$\begin{array}{r} 2.5\text{m} \\ -\ 1.2\text{m} \\ \hline 1.3\text{m} \end{array}$$

Illustrate this with meter and dm strips if necessary. Do several more examples.

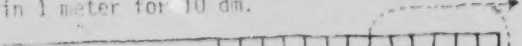
6. Assign page 20.

7. Page 21 involves borrowing. Illustrate it with the first problem.

$$\begin{array}{r} 2.3\text{m} \\ -\ 0.6\text{m} \\ \hline \end{array}$$

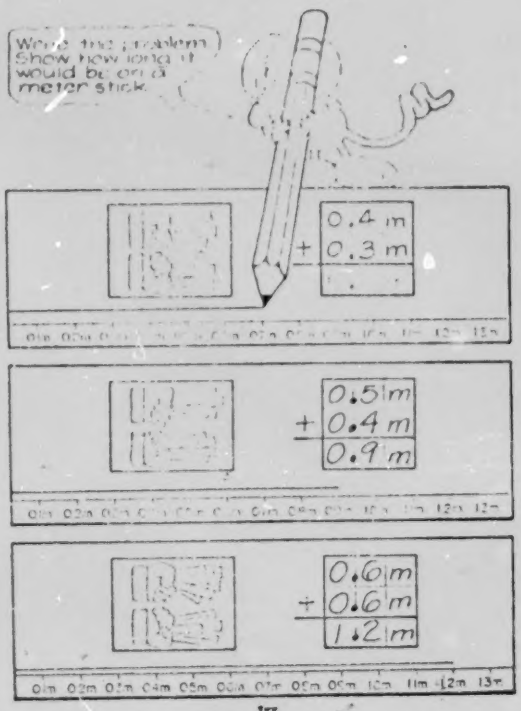


Layout 2 meters and 3 dm. "Since I cannot take 6 dm away from 3 dm, trade in 1 meter for 10 dm.



Then take away 6 dm. This leaves 1.7 m."

8. Assign page 22, a secret code, for additional practice adding and subtracting one place decimals.



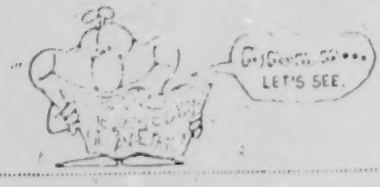
17

0.3m + 0.2m = 0.5m	0.3m + 0.6m = 0.9m	0.7m + 0.2m = 0.9m	0.3m + 0.4m = 0.7m	0.2m + 0.2m = 0.4m
0.6m + 0.2m = 0.8m	0.5m + 0.4m = 0.9m	0.3m + 0.1m = 0.4m	0.8m + 0.2m = 1.0m	0.7m + 0.7m = 1.4m
0.5m + 0.9m = 1.4m	0.4m + 0.8m = 1.2m	0.9m + 0.9m = 1.8m	0.8m + 0.8m = 1.6m	0.6m + 0.6m = 1.2m
0.5m + 0.5m = 1.0m	1.3m + 1.2m = 2.5m	1.6m + 1.3m = 2.9m	1.2m + 1.6m = 2.8m	1.4m + 1.5m = 2.9m
2.1m + 1.4m = 3.5m	1.6m + 3.2m = 4.8m	4.3m + 3.5m = 7.8m	2.7m + 3.2m = 5.9m	1.4m + 2.1m = 3.5m

18

1.6m + 1.8m = 3.4m	1.7m + 1.7m = 3.4m	1.9m + 1.3m = 3.2m	2.3m + 1.8m = 4.1m	2.7m + 1.4m = 4.1m
1.8m + 1.8m = 3.6m	2.9m + 0.4m = 3.3m	5.0m + 2.5m = 5.0m	2.3m + 0.9m = 3.2m	3.6m + 2.4m = 6.0m
2.2m + 3.8m = 6.0m	4.6m + 1.6m = 6.2m	3.5m + 3.5m = 7.0m	2.6m + 0.7m = 3.3m	3.9m + 4.8m = 8.7m
2.9m + 2.9m = 5.8m	4.5m + 4.5m = 9.0m	8.8m + 1.2m = 10.0m	5.5m + 4.5m = 10.0m	7.6m + 7.6m = 15.2m
6.8m + 3.3m = 10.1m	9.4m + 3.7m = 13.1m	4.6m + 8.5m = 13.1m	7.5m + 8.7m = 16.2m	3.3m + 6.8m = 10.1m

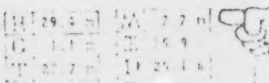
19



0.9m − 0.5m = 0.4m	0.5m − 0.3m = 0.2m	0.8m − 0.4m = 0.4m	0.6m − 0.2m = 0.4m	0.3m − 0.2m = 0.1m
0.8m − 0.6m = 0.2m	0.9m − 0.7m = 0.2m	0.7m − 0.5m = 0.2m	0.6m − 0.3m = 0.3m	0.9m − 0.2m = 0.7m
0.8m − 0.5m = 0.3m	0.7m − 0.4m = 0.3m	2.6m − 1.3m = 1.3m	2.3m − 1.1m = 1.2m	3.4m − 2.1m = 1.3m
1.4m − 0.2m = 1.2m	1.9m − 1.1m = 0.8m	3.5m − 2.5m = 1.0m	1.7m − 0.4m = 1.3m	4.4m − 0.2m = 4.2m
4.8m − 3.6m = 1.2m	5.9m − 2.7m = 3.2m	6.6m − 3.3m = 3.3m	9.8m − 5.4m = 4.4m	3.6m − 2.4m = 1.2m

20

3.3m − 0.6m = 1.7m	3.2m − 0.7m = 1.5m	3.0m − 0.9m = 1.1m	3.6m − 0.8m = 1.8m	2.5m − 0.8m = 2.7m
2.2m − 0.6m = 2.6m	3.8m − 0.9m = 3.9m	4.1m − 0.3m = 3.8m	2.3m − 1.7m = 1.6m	2.0m − 1.9m = 1.1m
3.1m − 1.5m = 1.6m	3.2m − 1.4m = 1.8m	3.5m − 1.6m = 1.9m	1.5m − 0.6m = 0.9m	4.2m − 1.5m = 2.7m
5.1m − 2.8m = 2.3m	1.2m − 0.8m = 0.4m	6.2m − 4.3m = 1.9m	4.0m − 0.5m = 3.5m	1.1m − 0.9m = 0.2m
8.1m − 7.2m = 0.9m	1.6m − 0.7m = 0.9m	5.0m − 2.5m = 2.5m	1.4m − 0.8m = 0.6m	9.1m − 8.9m = 0.2m



H	E	R	T	F	O	R	D
29.4m	36.1m	27.7m	27.7m	8.8m	4.4m	5.5m	10.9m

U	N	I	T	E	D
41.3m	25.7m	15.9m	27.7m	36.1m	25.1m

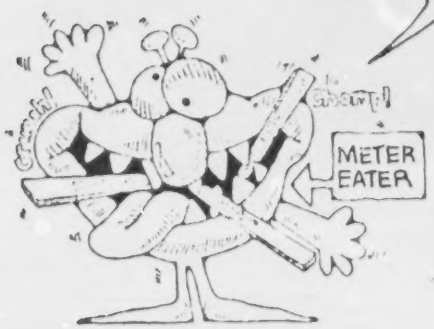
S	T	A	T	E	S
3.4m	27.7m	10.9m	27.7m	36.1m	3.4m

O	F
4.4m	8.8m

A	M	E	T	R	I	C	A
10.9m	7.7m	36.1m	27.7m	5.5m	15.9m	1.1m	10.9m

the 4th company

section 6 · decimals: hundredths of meters



Objectives: Given a meter strip marked in hundredths, measure and record lengths correct to the nearest hundredth of a meter.

Given meter, decimeter, and centimeter strips, write the corresponding decimal.

Materials: unmarked meter strip, cm ruler, meter strip marked in cm and labeled in hundredths of a meter prepared from page 57 of the Teacher's Guide or from adding machine tape, dm and cm units (metric-sized place value blocks and rods or dm and cm strips cut from page 55), meter marked in tenths (from Section 4), meter stick, several meter strips or sticks, hundredths ruler 4 meters long prepared from pages 59 to 63 of the Teacher's Guide

Vocabulary: hundredths of a meter

SUGGESTED PROCEDURES AND ACTIVITIES:

1. Quickly review for the class that since there are ten decimeters in a meter, a decimeter is one-tenth of a meter. Write 0.1 m on the board. Ask, "How many centimeters are in a meter?" Restate the correct answer, "There are 100 centimeters in a meter, so a centimeter is one-hundredth of a meter." Write it in two ways on the board:

$\frac{1}{100}$m 0.01m

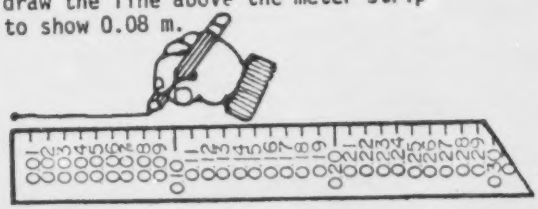
Explain that in the metric system we use the decimal form. Read 0.01 m as "one-hundredth of a meter" and as "zero point zero one meters". Explain that two cm are 0.02 m, three are 0.03 m, etc. Tape an unmarked meter strip on the board and use a cm ruler to mark off 15 cm. With class participation number the marks 0.01 through 0.09. Then ask, "How do you suppose we should write 10 cm as hundredths of a meter?" Let them think a minute, then write 0.10 m on the board. Ask about 11 cm, then write 0.11 m. Let students provide answers to the questions about 12 cm, 13 cm, etc.

At this point tape up a meter strip marked in hundredths of a meter (page 57 of the Teacher's Guide). Use it to show that there are 100 cm in a meter, and that on this ruler they are labeled as hundredths of a meter. The sequence of numbers run from 1 to 99, expressed as two-place decimals (There are two-places to the right of the decimal point.). Then ask how 25 cm would be written as hundredths of a meter. Write several decimal expressions on the board: 0.03 m, 0.18 m, 0.21 m, 0.05 m, 0.99 m. For each expression ask one student to read it. Ask the class to read it another way. (Either "three-hundredths of a meter" or "zero point zero three meters" is acceptable.) Then have the class tell you how many centimeters the expression represents. Repeat as necessary.

2. Ask students to turn to page 23 of their booklets. Explain that you will call out some number of cm and they are to write that length in decimal form as as hundredths of a meter. Caution them to remember the label "m". Then call out eight different cm lengths:

4 centimeters, 29 centimeters,
88 centimeters, 50 centimeters,
9 centimeters, 10 centimeters,
17 centimeters, 99 centimeters.

3. Using the meter strip marked in hundredths, tell the class you are going to draw a line "eight hundredths of a meter long". Ask them to show with their fingers or hands about how long the line should be. Then draw the line above the meter strip to show 0.08 m.



Ask them to show with their hands how long a line would be if it measured "zero point 95 meters". Then draw a line as before, above the meter strip to 0.95 m.

Now do page 24 as a group. Read to the class five decimals (one at a time) and have students draw lines on their paper to show how long it would be at the board. Explain that the pictures in their books are much smaller than a real meter, but they are to draw lines so that they fit the scale of the picture. Point out that the rulers in their books start at the top, so that their lines will begin at the top of each ruler, on the dot. Use: 0.51 m, 0.82 m, 0.03 m, 0.97 m, 0.17 m.

4. Have students turn to page 25. They are to cut out the five strips and tape them together to form a meter strip marked in hundredths of a meter. Check that all rulers are correctly taped before proceeding.

5. Do page 27 as a group. Students are to measure various lengths using their hundredths ruler. Round off to the nearest hundredth of a meter.

6. This presentation and the activity that follows (#7) may be more effectively done in groups of about 10 children gathered around a table on which m, dm, and cm strips can be easily manipulated.

Write 0.03 m on the board. Read it to the class. Hold up centimeter units (blocks or squares from page 55) and explain that you will show what 0.03 m means using them. Line up 3 cm units. Have someone hold his hundredths ruler against the units to show that they measure 0.03 m. Ask if someone can show you what 0.08 m means (write 0.08 m on the board). Then 0.05 m. Then write 0.10 m and ask if someone will show what that means. Check the line of 10 cm with a hundredths ruler to confirm the representation. Then show the class a tenths ruler (from Section 4), measure the 10 cm with it, and write 0.1 m on the board. Explain that 0.1 m and 0.10 m are the same length. Point out that 0.1 m means one decimeter and that 0.10 m means 10 centimeters - but we know that 10 cm <u>is</u> 1 dm.

Write 0.12 m and ask someone to represent it with the cm units. After you have shown that 12 cm is 0.12 m, lay one dm and 2 cm alongside the 12 cm. Ask, "Are these the same lengths? Are 12 cm the same as 1 dm and 2 cm? Yes." Point to 0.12 m written on the board. Explain that we can think of this in two different ways. It can means 12 cm, that is, 12 hundredths of a meter. Or it can mean 1 dm and 2 cm, that is, one tenth of a meter and two hundredths of a meter. Write 0.15 m and explain the two meanings, using dm and cm units to show each meaning and that they are the same length. Write 0.18 and ask a student to show and tell one meaning. Ask another student to show and tell the other meaning. Do a few more examples between 0.10 m and 0.20 m.

Then write 0.63 m and ask someone to tell you both meanings. Suggest that lining up 63 cm would be tiresome; ask the student to show what 0.63 m means using dm and cm. Do a couple more examples.

7. Have everyone take out a sheet of paper and do this practice problem at the top of the paper. Hold up 4 dm and 2 cm. Tell the class how

many of each you have in case they cannot all see. Ask them to write the decimal that shows how long they would be all lined up. Check that everyone has written 0.42 m. Correct and explain any errors. Then have them number from 1 to 5 on their papers and do five different problems: 0 dm 2 cm; 2 dm 6 cm; 5 dm 0 cm; 7 dm 1 cm; and 1 dm 3 cm.

8. Assign pages 28 and 29. Students are to express the decimeters and centimeters as hundredths of a meter.

9. Introduce decimal expressions for lengths of 1 meter or longer as follows. Tape a meter marked in hundredths to a meter stick to make it easier to use. Ask someone to come forward to have his height measured with the hundredths ruler. Hold the ruler next to the student to show that it is not long enough. Ask the class, "Our student is taller than one meter, but is he 2 m tall?" Show that the student is not 2 m tall but is 1 m and some more. Suggest that you measure how much more than a meter the student's height is by marking on a door or wall (with tape) where 1 m from the floor ends, and then using the ruler to measure from that mark to the student's head. "John is taller than 1 meter. How much taller?" Then write the difference on the board. For example.

1 m and 0.35m more

Ask if anyone knows how to write the height as one number in decimal form. Write on the board:

1.35m

Explain that the 1 to the left of the decimal point tells us we have one whole meter and the 35 to the right of the decimal point tells us we have 35 hundredths of a meter more (or 35 cm more). Write the following on the board:

0.25m
1.25m
2.25m

3.25m
10.25m
100.25m

Explain the meaning of each expression. Ask which length is the longest, which is the shortest. Have the class help you show the meanings of the expressions using meter sticks or strips and dm and cm units. Finally, write on the board:

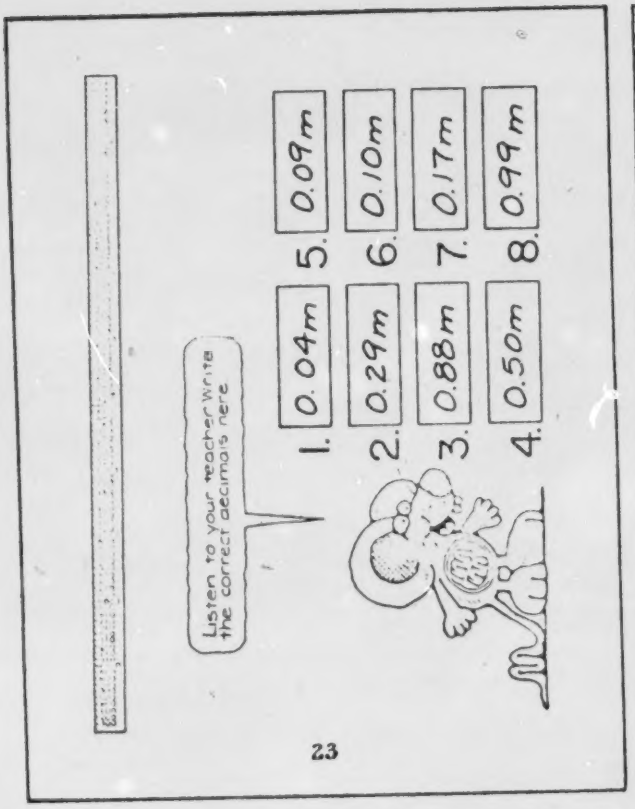
1.00m

Ask how that length could be shown. Explain that 1 m, 1.0 m, and 1.00 m are the same. They all mean one meter, no tenths, and no hundredths.

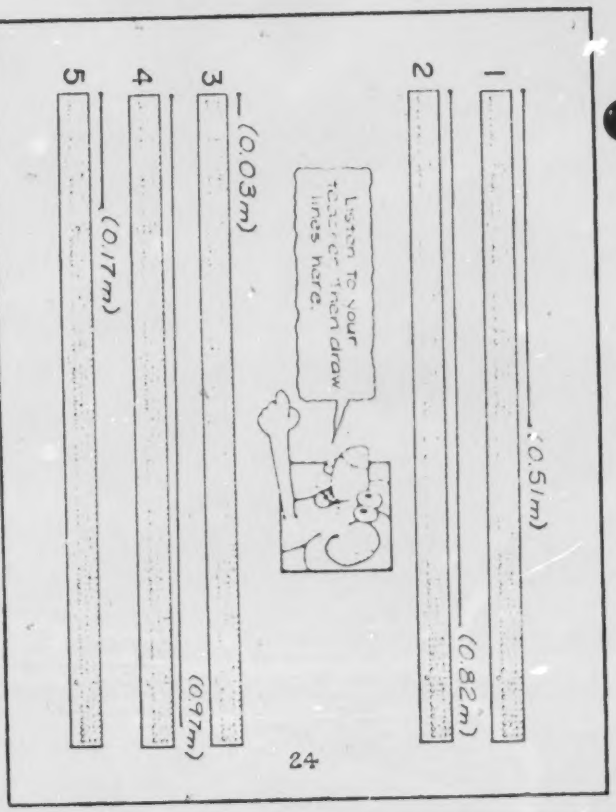
10. Hold up 1 meter, 3 dm, and 2 cm and ask, "Can you write how long these would be placed end-to-end: one meter, three decimeters, and two centimeters?" Write 1.32 m on the board. Then complete the activity on page 30. Hold up m, dm, and cm units and have students write the corresponding two-place decimals. Do ten problems in all using those shown on the answer page.

11. Assign page 31. While the class works at their desks, have pairs of students measure each other's heights. Provide a recording sheet where they record their heights in decimal form and write their names. Duplicate this list of names and heights and for homework have students write the names and heights of their classmates in order from shortest to tallest.

12. Make a hundredths ruler 4 meters long by cutting and taping together the strips on pages 59, 61, and 63 of the Teacher's Guide. (Or make one yourself from a 4 meter long strip of adding machine tape.) Attach it to a wall or chalkboard. Do the following kinds of activities periodically throughout the year.
    a. Call out a point between 0.01 m and 4.00 m and have a student come forward and locate it. Go around the room and see how fast students can locate their points.
    b. Call out and/or write two different lengths and ask which is the longer or shorter.
    c. Call out and/or write two different lengths and ask for a length in between them.



23



24

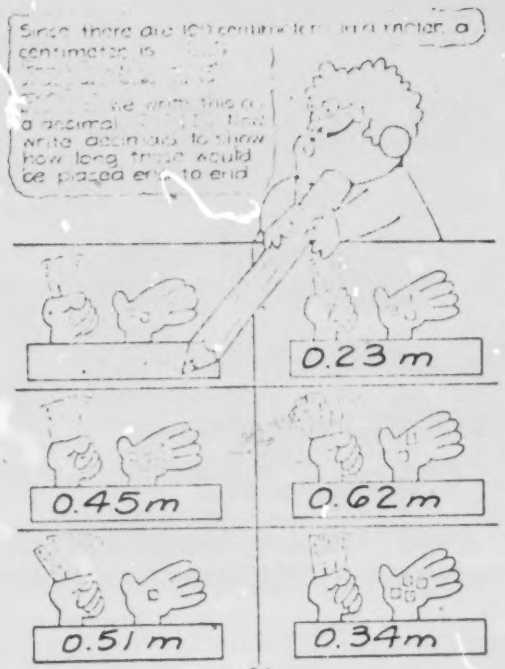
Cut out each strip. Tape together to make a meter.

	0.17 m	0.34 m	0.51 m	0.68 m	0.85 m
0.01 m	0.18 m	0.35 m	0.52 m	0.69 m	0.86 m
0.02 m	0.19 m	0.36 m	0.53 m	0.70 m	0.87 m
0.03 m	0.20 m	0.37 m	0.54 m	0.71 m	0.88 m
0.04 m	0.21 m	0.38 m	0.55 m	0.72 m	0.89 m
0.05 m	0.22 m	0.39 m	0.56 m	0.73 m	0.90 m
0.06 m	0.23 m	0.40 m	0.57 m	0.74 m	0.91 m
0.07 m	0.24 m	0.41 m	0.58 m	0.75 m	0.92 m
0.08 m	0.25 m	0.42 m	0.59 m	0.76 m	0.93 m
0.09 m	0.26 m	0.43 m	0.60 m	0.77 m	0.94 m
0.10 m	0.27 m	0.44 m	0.61 m	0.78 m	0.95 m
0.11 m	0.28 m	0.45 m	0.62 m	0.79 m	0.96 m
0.12 m	0.29 m	0.46 m	0.63 m	0.80 m	0.97 m
0.13 m	0.30 m	0.47 m	0.64 m	0.81 m	0.98 m
0.14 m	0.31 m	0.48 m	0.65 m	0.82 m	0.99 m
0.15 m	0.32 m	0.49 m	0.66 m	0.83 m	
0.16 m	0.33 m	0.50 m	0.67 m	0.84 m	

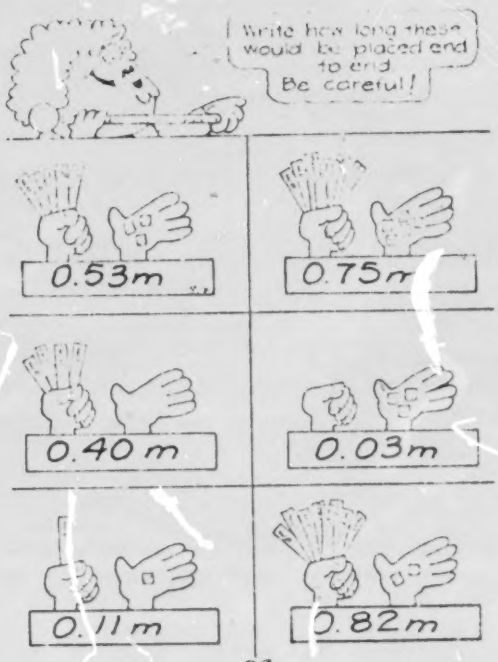
25

length of my desk _____
width of my desk _____
length of my metric booklet _____
width of my metric booklet _____
my waist _____
length of my foot _____

27



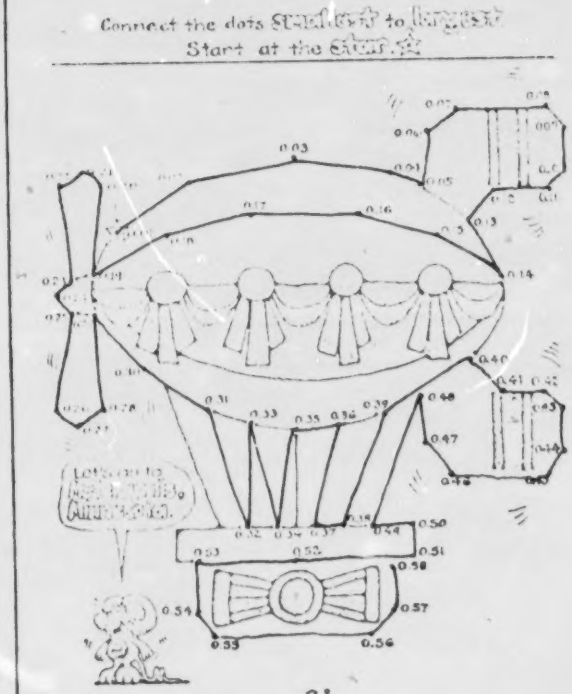
28



29

1. 1.23m
2. 4.12m
3. 1.01m
4. 2.03m
5. 0.50m
6. 0.60m
7. 2.00m
8. 1.11m
9. 0.09m
10. 0.00m

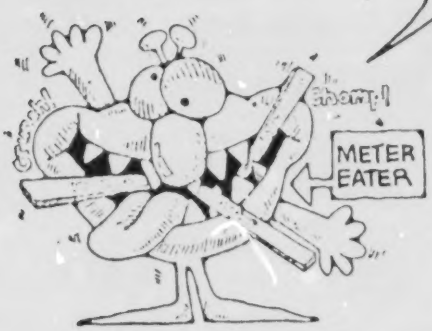
30



31

the 4m company

section 7 · decimals: add hundredths of meters



Objectives: Given two expressions involving hundredths of a meter, find their sum.

Materials: meter numbered in hundredths (from Section 6), meter strips or sticks, dm and cm units (from Section 6)

Vocabulary: "carry the one", "exchange ten for one"

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Quickly review adding tenths of meters.

$$\begin{array}{r} 0.3\text{m} \\ +0.2\text{m} \\ \hline 0.5\text{m} \end{array}$$

Use a meter marked in tenths and dm blocks or strips to illustrate if necessary. Review that adding decimals is just like adding whole numbers except we bring the decimal point straight down in the answer.

2. Write on the board:

$$\begin{array}{r} 0.03\text{m} \\ +0.02\text{m} \\ \hline \end{array}$$

Explain that we know how to add tenths of meters and ask if anyone can guess how we add hundredths of meters. Do the addition for the class: Add from right to left then bring down the decimal point and label the answer. Write "m" for meters.

$$\begin{array}{r} 0.03\text{m} \\ +0.02\text{m} \\ \hline 0.05\text{m} \end{array}$$

Illustrate the addition using cm units and the hundredths ruler. Line up 3 "hundredths of a meter" (3 cm) and then 2 "hundredths of a meter" (2 cm) more. Measure the whole length to show its sum is 0.05 m. Do several more examples with answers less than 0.10 m. Explain that adding hundredths is like adding tenths: we add just like whole numbers except we bring the decimal point straight down.

3. Write on the board:

$$\begin{array}{r} 0.05\text{m} \\ +0.07\text{m} \\ \hline \end{array}$$

Set out 5 "hundredths of a meter" (5 cm), then 7 "hundredths of a meter" (7 cm) and ask how many hundredths of a meter we have lined up altogether. Measure the line of 12 units to show that we have 0.12 m. Write the answer on the board.

$$\begin{array}{r} 0.05\text{m} \\ +0.07\text{m} \\ \hline 0.12\text{m} \end{array}$$

Do several more examples on the board having students write the answers.

4. Write on the board:

$$\begin{array}{r} 0.32\text{m} \\ +0.25\text{m} \\ \hline \end{array}$$

Ask students to consider that if you had a strip of paper 0.32 m long and another 0.25 m long and taped them end to end, how long would the total strip of paper measure. Use dm and/or cm units to illustrate the problem. Line up 3 dm and 2 cm and measure with a hundredths ruler as 0.32 m; line up 2 dm and 5 cm and measure as 0.25 m. Then line them all up end to end and measure with a hundredths ruler to show the total length as 0.57 m. Write the answer on the board.

$$\begin{array}{r} 0.32\text{m} \\ +0.25\text{m} \\ \hline 0.57\text{m} \end{array}$$

Observe that you have added hundredths of meters just like you do whole numbers. Do several more examples using problems that involve no carrying. Have students write the answers on the board. Remind them to write the unit symbol and the decimal point if they forget.

5. Write on the board:

$$\begin{array}{r} 1.34\text{m} \\ +2.15\text{m} \\ \hline \end{array}$$

Ask someone to do this addition problem. Explain and illustrate the addition if necessary. Do several more examples on the board. Use no problems that involve carrying, but include problems like the following:

$$\begin{array}{r} 0.26\text{m} \\ +2.13\text{m} \\ \hline \end{array} \qquad \begin{array}{r} 13.62\text{m} \\ +21.16\text{m} \\ \hline \end{array}$$

$$\begin{array}{r} 20.03\text{m} \\ +\ 0.04\text{m} \\ \hline \end{array} \qquad \begin{array}{r} 0.30\text{m} \\ +10.08\text{m} \\ \hline \end{array}$$

6. Explain the first example on page 32. Then assign pages 32, 33, and 34.

7. Page 35 is designed to reinforce addition skills involving "carrying". The following presentation is designed to "explain" carrying in terms of concrete, physical models. Do not expect all students to fully comprehend the explanation. The most important thing at this stage is that children learn to add.

Briefly explain the process of "carrying" using the meter, decimeter, and centimeter units as follows. (Presentation may be more easily and effectively done with a group of about 10 students at a table.) Write this problem on the board:

$$\begin{array}{r} 1.48\text{m} \\ +0.74\text{m} \\ \hline \end{array}$$

Have students represent each number using meter, dm, and cm units: lay 1 m, 4 dm, and 8 cm end to end to show 1.48 m; lay 7 dm and 4 cm end to end to show 0.74 m. Explain that by adding these two lengths we will find out how long they would be all lined up. Then line them all up: first the meter, then all 11 dm, then all 12 cm. Count the m, dm, and cm units in the total lined up. Refer to the written problem, pointing out that 8 + 4 = 12 and 4 + 7 = 11 and 1 + 0 = 1. But we have no way to write a two-place decimal for 1 m, 11 dm, and 12 cm, since only one number can go in each place. Suggest that we do some exchanging.

Count the 12 cm and explain that since 10 cm = 1 dm we can exchange 10 cm for 1 dm. Make the exchange with your blocks and write the first step of your calculation on the board:

$$\begin{array}{r} {\scriptstyle 1} \\ 1.48\text{m} \\ +0.74\text{m} \\ \hline 2 \end{array}$$

Explain that the 1 you are "carrying" stands for the exchange you made of 10 cm for 1 dm. It means you have one more dm to add to those already written. (You may choose to use the words "exchange ten for one" or something similar instead of "carrying".)

Now count the dm units. You should count 12 dm altogether. Go to the written problem and add 1 + 4 + 7 to get 12. Again we have no way to write the 12 dm in the decimeter place so suggest exchanging dm for meters. Count out 10 dm and replace with 1 meter since 10 dm = 1 m. Then write the next step on your calculation.

$$\begin{array}{r} {\scriptstyle 1\ 1} \\ 1.48\text{m} \\ +0.74\text{m} \\ \hline 22 \end{array}$$

Explain that the 1 you are "carrying"

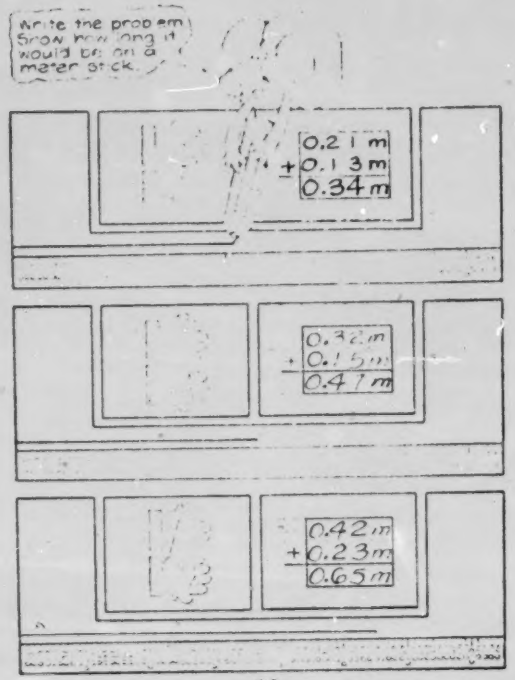
stands for the exchange you made of 10 dm for 1 m, and that you must add this extra meter to the one you already have. Complete the calculation on the board.

$$\begin{array}{r} {\scriptstyle 1\ \ 1} \\ 1.48\text{m} \\ +0.74\text{m} \\ \hline 2.22\text{m} \end{array}$$

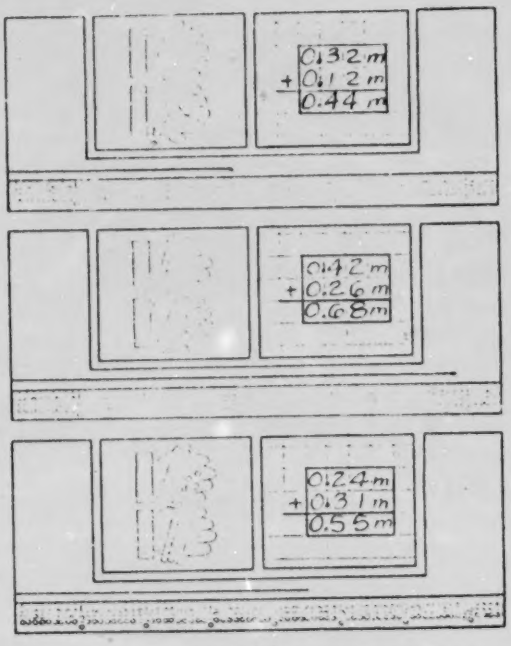
Write another problem and go through each step verbally. When you "carry the one" or "exchange ten for one" explain that you are exchanging 10 cm for 1 dm (or 10 dm for 1 m) and recording that extra dm (or m) to be added with the other dm (or m) you have.

$$\begin{array}{r} 1.67\text{m} \\ +0.97\text{m} \\ \hline \end{array}$$

Use the m, dm, and cm units to illustrate the problem if necessary. Do a few more examples with the students. Include several types of problems: no carries, one carry only, several carries, a column sum of ten. Then assign page 35.



32



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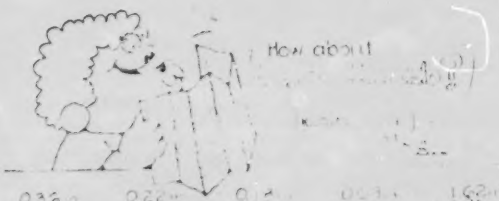


0.57m 0.66m 0.69m 0.88m 2.97m

5.55m 9.99m 8.59m 2.38m 0.28m

24.68m 33.87m 38.19m 43.14m 68.18m

8.38m 7.77m 55.54m 66.66m 87.81m

515.88m 999.99m 177.77m

34

2.02m 2.42m 2.40m 1.15m 2.54m

2.72m 5.80m 2.81m 3.24m 5.46m

1.88m 9.62m 15.00m 6.11m 3.00m

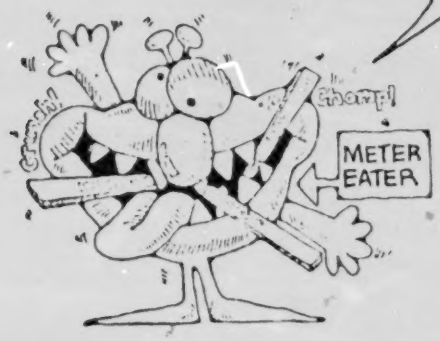
5.00m 7.00m 9.00m 1.30m 2.00m

41.24m 25.00m 50.00m 21.11m 1.00m

35

the 4m company

section 8 · decimals: subtract hundredths of meters



Objectives: Given two expressions involving hundredths of a meter, find their difference.

Materials: meter numbered in hundredths, meter strips or sticks, dm and cm units

Vocabulary: "borrow one", "exchange one for ten"

SUGGESTED PROCEDURES AND ACTIVITIES:

1. Ask, "If I had seven-hundredths of a meter and took away three-hundredths, how much would I have left?" Write on the board:

$$\begin{array}{r} 0.07\text{m} \\ -0.03\text{m} \\ \hline \end{array}$$

Then lay seven cm units end to end and measure with a hundredths ruler to show that you have 0.07 m. Take away three cm units and observe by measuring that the result is four-hundredths of a meter. Record the difference on the board.

$$\begin{array}{r} 0.07\text{m} \\ -0.03\text{m} \\ \hline 0.04\text{m} \end{array}$$

Explain that subtracting decimals, whether they are tenths or hundredths, is just like subtracting whole numbers, except that we bring the decimal point straight down in the answer.

Write another problem on the board:

$$\begin{array}{r} 0.35\text{m} \\ -0.12\text{m} \\ \hline \end{array}$$

Represent 0.35 m with dm and cm units, take away 0.12 m and observe that the result, as measured with a hundredths ruler, is 0.23 m. Observe that this is the same answer we would get if we just subtract normally and bring down the decimal point. Do the subtraction on the board, carefully describing each step.

$$\begin{array}{r} 0.35\text{m} \\ -0.12\text{m} \\ \hline 0.23\text{m} \end{array}$$

Work another simple problem with the class.

$$\begin{array}{r} 2.68\text{m} \\ -1.34\text{m} \\ \hline \end{array}$$

Then assign page 36, simple subtraction with no "borrowing".

2. Page 37 is designed to reinforce subtraction skills involving "borrowing". Briefly explain the process of borrowing using meter, decimeter, and centimeter units as follows. Write this problem on the board:

$$\begin{array}{r} 2.35\text{m} \\ -0.49\text{m} \\ \hline \end{array}$$

Have students represent 2.35 m using meter, dm, and cm units; lay 2 m, 3 dm, and 5 cm units end to end. Explain that subtracting 0.49 m would be to take 4 dm and 9 cm from those we have lined up. Ask, "How many cm should we take away? Nine. But we only have five in our 2.35 m. Can anyone think of a way to take away 9 cm

units?" Suggest exchanging 1 dm for 10 cm. Do the actual exchange then ask, "How many dm and cm units do we have now after the exchange?" Make adjustments on the problem to show your exchange:

$$\begin{array}{r} {\scriptstyle 2\ 15} \\ 2.3\not{5}\text{m} \\ -0.49\text{m} \\ \hline \end{array}$$

Now take 9 cm from the 15 cm. Ask how many cm units are left. Write 6 in the problem pointing out that 15 - 9 = 6.

$$\begin{array}{r} {\scriptstyle 2\ 15} \\ 2.3\not{5}\text{m} \\ -0.49\text{m} \\ \hline 6 \end{array}$$

Examine the problem and ask, "How many dm must we take away? How many dm do we have?" Point out that after the exchange of 1 dm for 10 cm we have one less dm than before. We have 2 dm and we need to subtract 4 dm. Ask how we can get more dm units and hope that someone suggests exchanging 1 m for 10 dm. Make the exchange and count the resulting meter and dm units. Record the adjustments on the board:

$$\begin{array}{r} {\scriptstyle 1\ 12\ 15} \\ 2.\not{3}5\text{m} \\ -0.49\text{m} \\ \hline 6 \end{array}$$

Take 4 dm units from the units you set out and count the remainder. Point out on the board that 12 - 4 = 8 and record 8 in the answer:

$$\begin{array}{r} {\scriptstyle 1\ 12\ 15} \\ 2.\not{3}5\text{m} \\ -0.49\text{m} \\ \hline 86 \end{array}$$

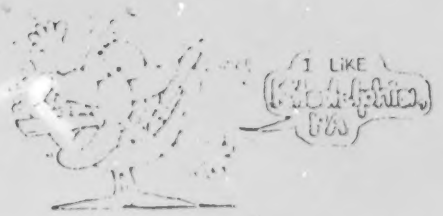
Ask how many meters we need to take away. Since it is zero, 1 - 0 = 1. Finish writing the answer on the board:

$$\begin{array}{r} {\scriptstyle 1\ 12\ 15} \\ 2.\not{3}5\text{m} \\ -0.49\text{m} \\ \hline 1.86\text{m} \end{array}$$

Now refer to the model where there should be 1 m, 8 dm, and 6 cm left. Carefully review each step of the written problem. Do a few more examples on the board. Use m, dm, and cm units as necessary. Include several types of problems: no borrowing, one borrow only, several borrows, a column subtraction from zero, a borrow from zero.

1.38m	1.24m	1.35m	1.04m	1.02m
-0.12m	-1.07m	-0.76m	-0.82m	-0.36m

Assign page 37.



0.03m	0.05m	0.03m	0.05m	0.12m
0.13m	0.12m	0.14m	1.31m	1.44m
5.55m	3.31m	1.03m	0.10m	5.16m
3.02m	11.11m	22.22m	33.33m	

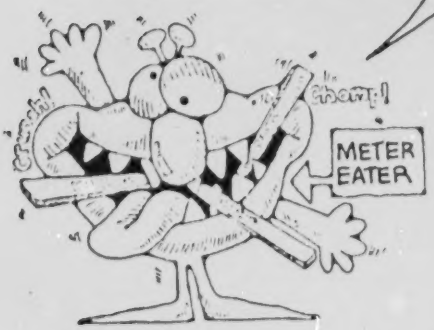
36

1.86m	0.68m	1.54m	1.57m	0.82m
0.53m	2.25m	0.31m	1.66m	0.18m
0.77m	0.09m	2.01m	1.86m	0.99m
16.28m	1.42m	25.25m	17.50m	0.01m
9.30m	33.33m	59.92m	55.55m	312.14m

37

the 4th compAny

section 9 · capacity: liter · deciliter · centiliter



Objectives: Given a liter measure, determine the capacity of a container to the nearest liter.

Given a deciliter measure, determine the capacity of a container to the nearest deciliter.

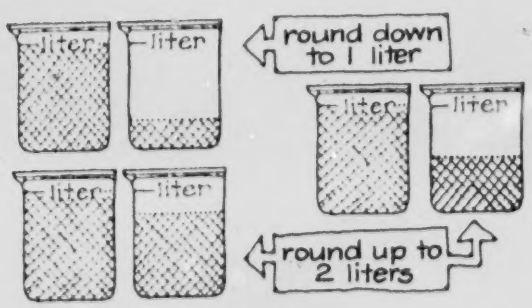
Given a centiliter measure, determine the capacity of a container to the nearest centiliter.

Materials: 2 large containers to measure in liters, liter measures; for page 39 a liter, dℓ, and cℓ measure; for page 40 an empty soda can, an empty 8-oz. milk carton (lunch milk size), a paper cup, a dℓ measure; for the Taste Test 1 quart bottle of Malolo syrup (or similar fruit punch syrup concentrate), three pitchers or liter containers, small tasting cups (3 per student -- 1/2 oz. paper portion containers are suggested), paper cups (1 per student), dℓ measure, cℓ measure; for the game a variety of jars and bottles, 2 small identical clear jars with marks at the 1 dℓ level.

Vocabulary: liter, deciliter, centiliter, round off, round up, round down

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Fill a large container with water (a gallon will do) and ask, "How much water does this container hold?" After students have made several guesses, introduce the liter as the standard unit for measuring liquids in the metric system. Write the word "liter" and its symbol "ℓ" on the board. Have a volunteer come forward to find the capacity of the large container. As the student empties the water into liter containers (or a single container), have the class keep count. If the measure is not exact, explain how to round off to the nearest liter, using the following procedure: If less than 1/2 liter of water is in the last liter container, round down; if 1/2 liter or more, round up.



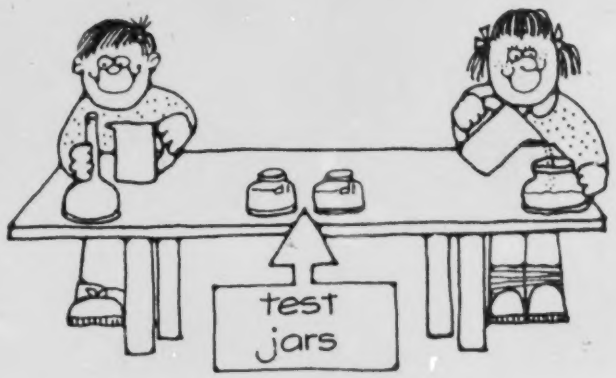
Repeat the measuring and rounding off procedure with another large container. Then assign page 38.

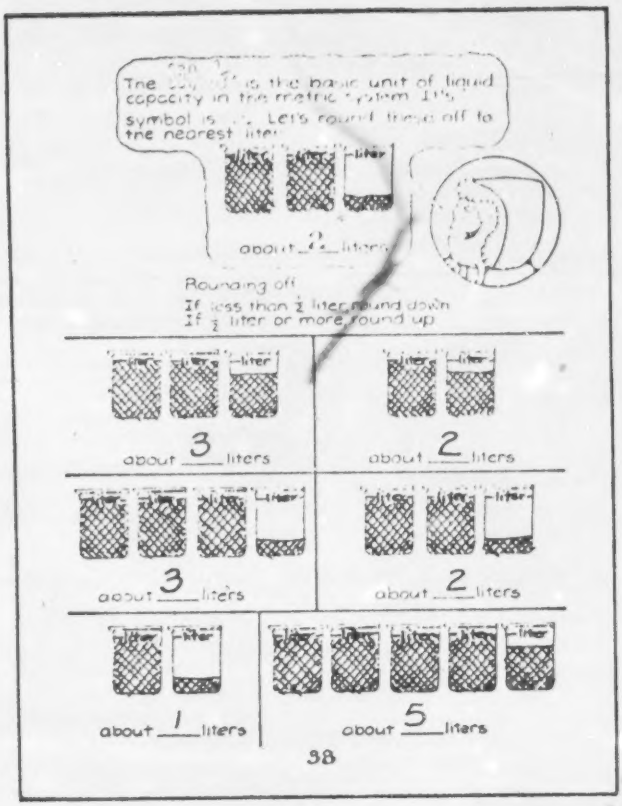
2. Turn to page 39. Use it to introduce the deciliter and centiliter. Have a student verify that ten deciliters fill the liter, and that ten centiliters fill a deciliter. Students should complete the equations on page 39. Hopefully they will see that 100 centiliters = 1 liter. Write "centiliter" and "deciliter" on the board. Have children practice writing the words in their notebooks (perhaps 6 times each).

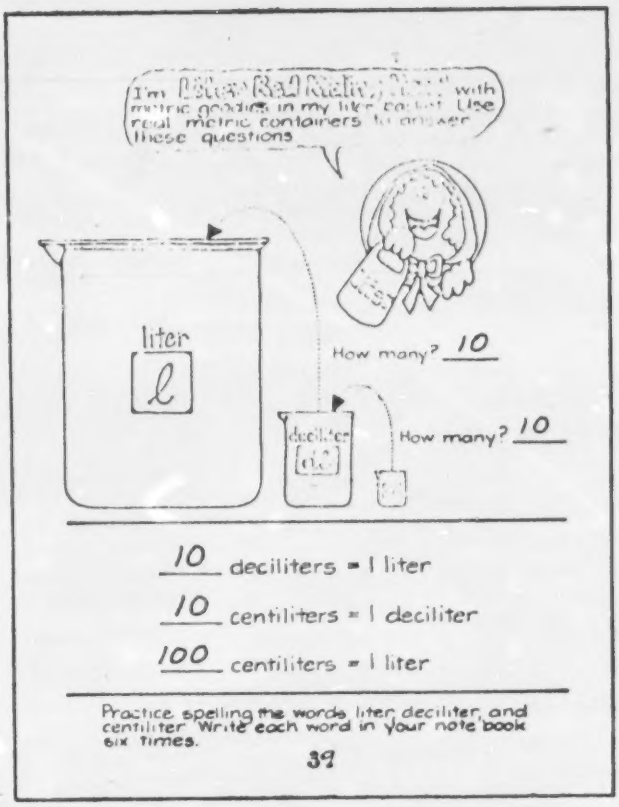
3. Turn to page 40. Set out several deciliter containers, an empty soda can, an empty 8 oz. milk carton, and a paper cup. Let students work in small groups to complete the exercises on the page.

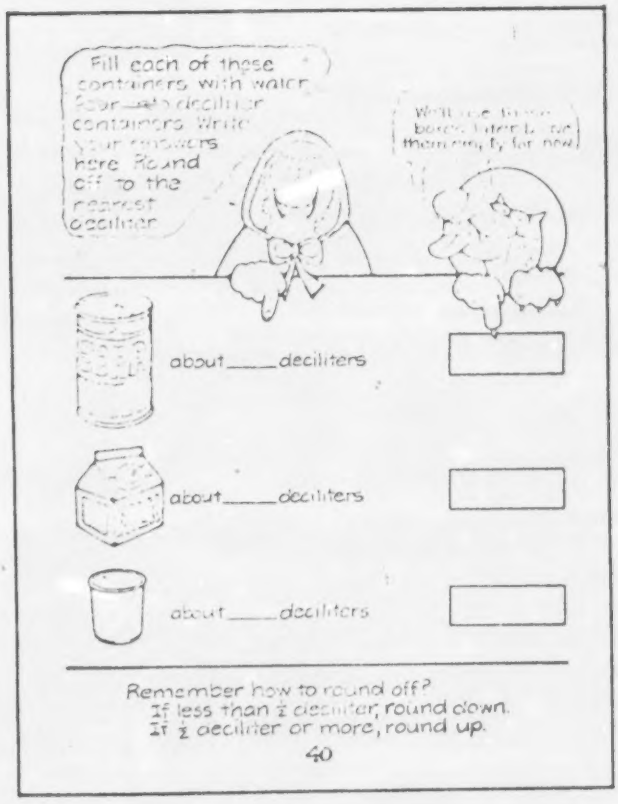
4. The Taste Test: For this you'll need a quart of Malolo syrup (or similar brand), three pitchers or liter containers, deciliter measure (3 1/2 oz. plastic solo cups will do), enough small tasting cups for each student to have three) (1/2 oz. size paper portion containers are perfect), and later enough paper cups for one per student. Explain that the recipe on the syrup bottle suggests mixing 1 part of syrup with 5 parts of water. Write that recipe on the board and explain what it means. "If we use one dℓ of syrup we should use 5 dℓ of water, if we use one cℓ of syrup we should use 5 cℓ of water, and if we are making punch for a party and want lots we can use one liter of syrup then how much water? Five liters of water. That is what 1 part with 5 parts means." Explain that you are going to test their recipe along with two others to see which one tastes best. Write the following two recipes on the board: 1 part syrup with 4 parts water, 1 part syrup with 6 parts water. Have three different students come forward, one at a time, and make one of the recipes in a pitcher (or liter container) using the dℓ measure. When all three recipes have been made, pour taste samples into small paper cups and have students, one at a time, come forward to taste all three and choose his favorite. (You may wish to let another student keep a running tally on the chalkboard for each of the recipes.) After everyone has selected his favorite recipe (1 to 4, 1 to 5, 1 to 6), tell the class which was your favorite and demonstrate using the cℓ measure how to make a single glass of punch. Let each student make his own glass of punch using the recipe he preferred. Consider allowing them to make punch one at a time while the class is working on another subject at their seats.

5. Divide the class into two teams to play the the following game. You will need the following equipment: 2 identical dℓ measures (2 small, identical clear jars with marks at the 1 dℓ level are suggested); a variety of jars, cups, and bottles; and two pitchers of water. Set the two identical dℓ measures side by side where all can see them. At either end of the demonstration table set a pitcher of water. Place one of the various jars or bottles by each pitcher. Have one member from each team come forward and try to pour "exactly" one dℓ of water into the jar or bottle on that team's side. To determine which team gets the point, pour each guess into a dℓ container and compare them side by side. The team closer to the dℓ mark wins the point. In case of ties award duplicate points.



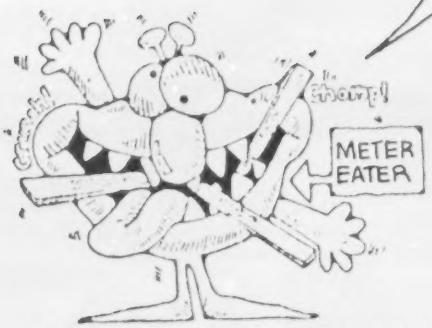

The liter is the basic unit of liquid capacity in the metric system. It's symbol is l. Let's round these off to the nearest liter.
liter
about 2 liters
Rounding off
If less than ½ liter, round down
If ½ liter or more, round up
about 3 liters
about 2 liters
about 3 liters
about 2 liters
about 1 liters
about 5 liters
38


I'm Liter Bad Rudie, ... with metric goodies in my like ... Use real metric containers to answer these questions.
liter
l
How many? 10
deciliter
dl
How many? 10
10 deciliters = 1 liter
10 centiliters = 1 deciliter
100 centiliters = 1 liter
Practice spelling the words liter, deciliter, and centiliter. Write each word in your note book six times.
39


Fill each of these containers with water. Soar ... deciliter containers. Write your answers here. Round off to the nearest deciliter.
about ___ deciliters
about ___ deciliters
about ___ deciliters
Remember how to round off?
If less than ½ deciliter, round down.
If ½ deciliter or more, round up.
40

the 4th company

section 10 · metric prefixes



Objectives: Recall the meanings of three metric prefixes: deci means "tenth", centi means "hundredth", and milli means "thousandth".

Materials: liter measure, dℓ measure, cℓ measure, mℓ measure (cut from page 65 of the Teacher's Guide), 100 mℓ graduated cylinder (see your science department), 2 containers to be measured in mℓ (labeled J and K), aquarium and large bucket or tub (optional), 12 meter sticks, tape

Vocabulary: milliliter, dekaliter, hectoliter, kiloliter

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Hold up a demonstration meter stick which shows meter, decimeters, centimeters, and millimeters. Then hold up a liter, deciliter, and centiliter. Ask, "What would the next smaller unit for measuring liquid be called?" Answer: milliliter. Show the students a milliliter (cut from page 65 of your Teacher's Guide). Explain that

   $10\ m\ell = 1\ c\ell$
   $10\ c\ell = 1\ d\ell$
   $10\ d\ell = 1\ \ell$

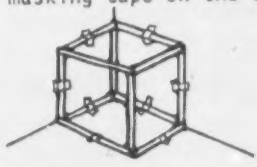
   If a graduated cylinder is available, explain that since a mℓ is so small, cylinders are usually used to measure mℓ. Pour some water into it to illustrate how it is read. Page 41 provides practice reading a graduated cylinder marked in mℓ. Note that the numbers are kept simple at this stage.

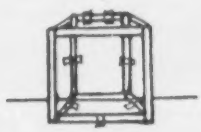
   Set out a graduated cylinder with two containers marked J and K. Have students find their capacities in milliliters and record on page 41. Caution them that the milliliter is a very small unit and therefore they must be very careful in measuring. Expect differences in answers.

2. Turn to page 42 and discuss metric prefixes. Review that the prefixes milli, centi, and deci are for units smaller than the basic unit. Review the meanings of milli, centi, and deci. Refer to the liter, dℓ, cℓ, and mℓ containers to illustrate your points. Discuss kilo, hecto, and deka as prefixes for units larger than the basic unit.

   Point out that the meanings of the prefixes are constant, that "kilo" always means "thousand" etc. Thus, a kilometer is 1000 meters and a kiloliter is 1000 liters, etc. Let children use the chart to answer such questions as, "How much is a dekaliter?" Answer: 10 liters. Then reverse it by asking, "What is another name for one tenth of a liter?" Answer: a deciliter. Then have students complete the chart at the bottom of the page. Discuss the various symbols, pointing out that the first part stands for the prefix, and the last part for the base unit.

3. Explore dekaliter, hectoliter, and kiloliter through the following activities. If you have an aquarium or large bucket or tub, see how many liters they hold. If one holds 10 ℓ point this out as a dekaliter. If the aquarium is very large (about 25 gallons) it may hold almost 100 liters (25 gallons is about 95 ℓ, 15 gallons is about 57 ℓ, 10 gallons is about 38 ℓ). In one corner of the room tape 12 meter sticks together to make a cube. Use the corner (or one wall if a corner is unavailabe) to support the structure. Tape the sticks to the walls and floor for stability. Use masking tape on the corners.





Explain that if this cube had sides, it would hold one kiloliter of water. The kiloliter is used to measure large capacities like those of tank trucks, water towers, and swimming pools.

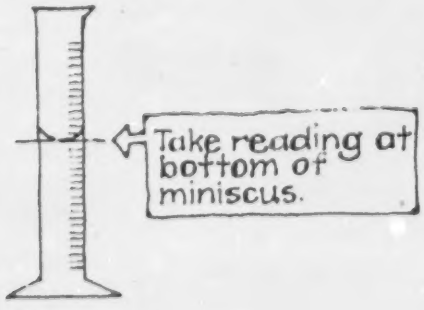
4. Have the class do page 43. Discuss the answers.

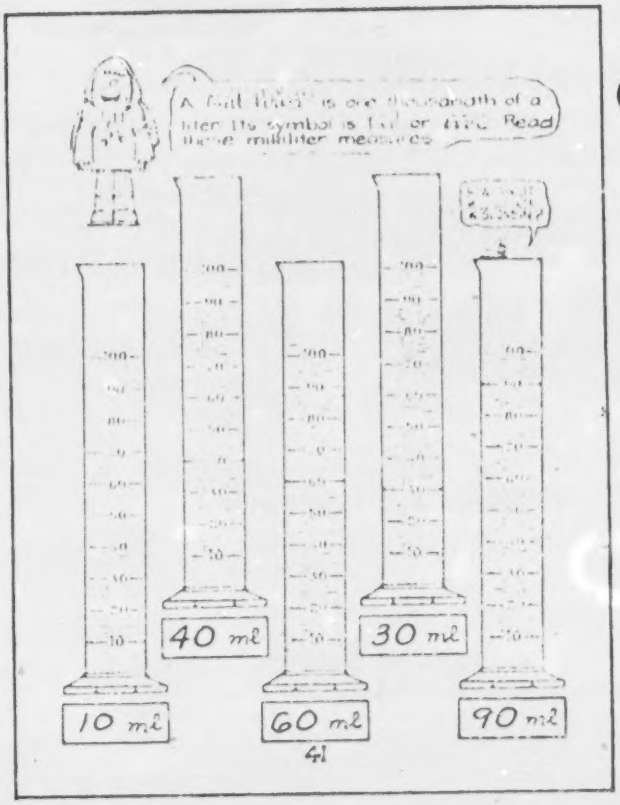
5. Assign page 44.

6. Take six sheets of light colored construction paper or cardboard. Write each of the six prefixes on a card. On the back of each card write the meaning of the prefix. Use these cards to drill the students on prefixes. Hold up a prefix, ask students to read it and give its meaning. Then turn the cards around, show the value and ask for the corresponding prefix. Then have students turn to page 45 and cut out the six flashcards provided there. Pair each student with a neighbor and have them practice the prefixes. Circulate to correct errors and misunderstandings. Students should keep these flashcards to practice throughout the year.

Try this game: Arrange students in threes. One student is the dealer and exposes one number at a time. The other two compete to see who can be the first to call out the corresponding prefix.

A NOTE TO THE TEACHER about using graduated cylinders: If the cylinder is glass, water will tend to adhere to the sides making the water level a curve rather than a horizontal line. This is called a miniscus, and the reading should be made at the bottom of the miniscus. Usually no miniscus forms in plastic cylinders.





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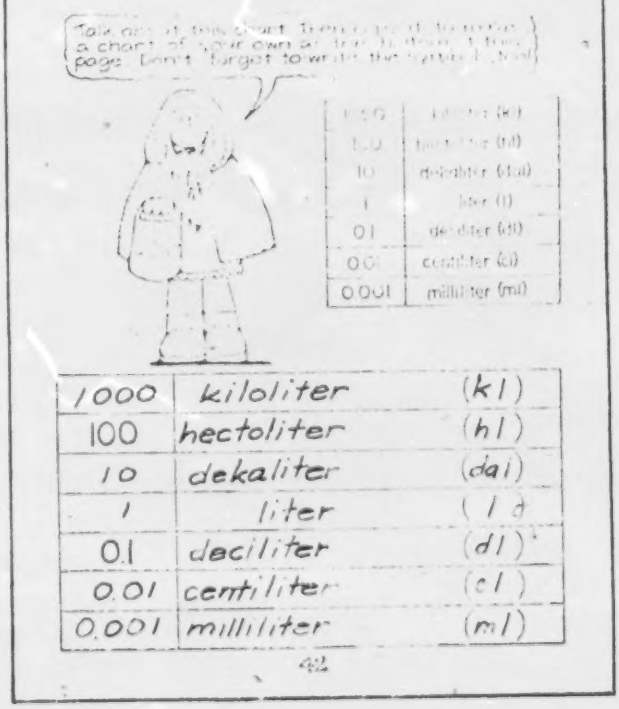
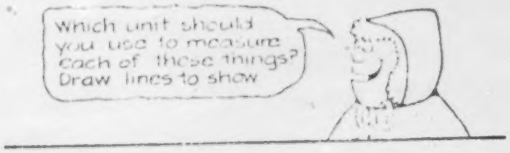
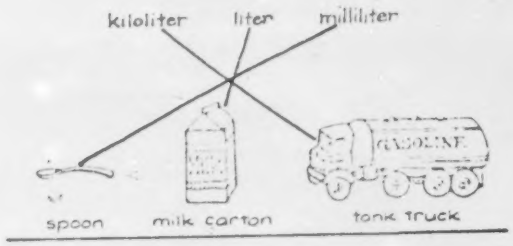
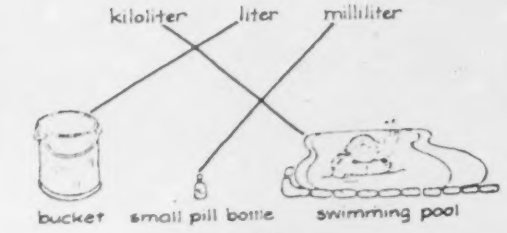


1000	kiloliter	(kl)
100	hectoliter	(hl)
10	dekaliter	(dal)
1	liter	(l)
0.1	deciliter	(dl)
0.01	centiliter	(cl)
0.001	milliliter	(ml)

42







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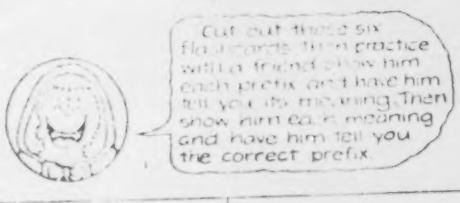
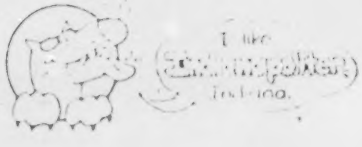
44


Cut out these six flashcards. Then practice with a friend. Show him each prefix and have him tell you its meaning. Then show him each meaning and have him tell you the correct prefix.

deci (d)	deka (da)
centi (c)	hecto (h)
milli (m)	kilo (k)

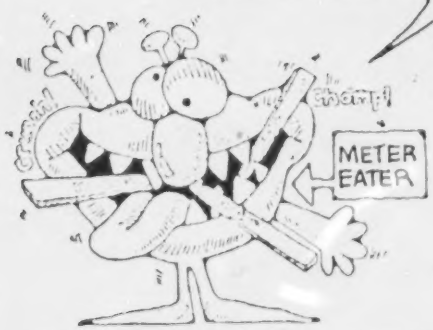
45



46

the 4th company

section 11 · decimals: tenths of liters



Objectives: Given two expressions involving tenths of a liter, find their sum.

Given two expressions involving tenths of a liter, find their difference.

Materials: liter measures, dℓ measures (3 1/2 oz. plastic Solo cups hold 1 dℓ), soda can, 8 oz. milk carton, and paper cup from Section 9

Vocabulary: tenths of a liter, "___ point ___ liters"

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Turn back to page 13 and review how decimeters can be expressed as tenths of a meter. Explain that the same procedure holds true for deciliters. Write several expressions on the board, such as 0.5 ℓ, 0.7 ℓ, etc. Have students tell you how many deciliters each expression represents.

2. Hold up 3 dℓ and ask, "How can I write this as part of a liter?" Write 0.3 ℓ on the board. Repeat with other examples. Then assign page 47.

3. Write a decimal on the board and ask a student to pick up the corresponding number of deciliters. Repeat with 8 or 10 different students.

4. Hold up a liter and 2 dℓ and ask, 'How can I express this as a decimal?" Write 1.2 ℓ on the board. Do several other examples, then assign page 48.

5. Write a problem such as $\begin{array}{r} 0.5\,\ell \\ +0.1\,\ell \\ \hline \end{array}$

   on the board. Students should be able to give you the sum. Illustrate it with dℓ measures. Then explain how to add decimals, bringing the point straight down, etc. Assign page 49.

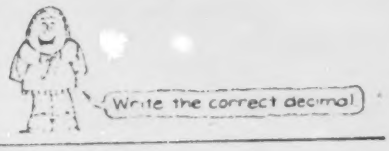
6. Use a similar procedure for subtraction. Set out 8 dℓ. "This is eight-tenths of a liter. If I take two-tenths away, how much will be left?" Write the problem on the board, then take 2 dℓ away". There are 0.6 ℓ left".

$$\begin{array}{r} 0.8\,\ell \\ -0.2\,\ell \\ \hline 0.6\,\ell \end{array}$$

   Explain that adding and subtracting decimals is just like adding and subtracting whole numbers, except that the decimal is brought straight down in the answer. Assign page 50.

7. In this exercise students are to record their findings in tenths of liters. Set out the soda can, 8 oz. milk carton, and glass you used in Section 9 for page 40 of the student book. Have students fill each container, and pour the contents into deciliters. Count the capacity as the number of deciliters filled. Recording boxes are provided on the right side of page 40.

   When completed, discuss the findings with the entire class, pointing out that 3 dℓ is 0.3 ℓ, etc.



0.2 ℓ

0.5 ℓ

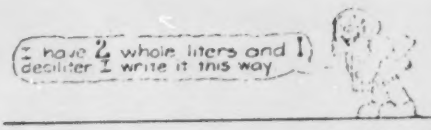
0.3 ℓ

0.4 ℓ

0.1 ℓ

0.6 ℓ

47



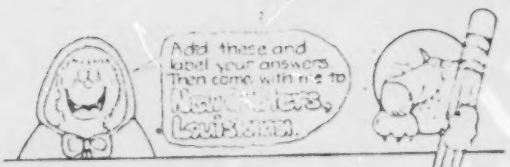
1.4 ℓ

3.2 ℓ

2.3 ℓ

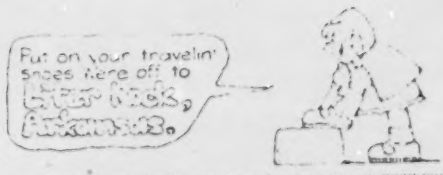
1.5 ℓ

48



0.7 ℓ	0.7 ℓ	0.9 ℓ	0.9 ℓ	1.2 ℓ
1.5 ℓ	1.1 ℓ	1.3 ℓ	1.0 ℓ	1.9 ℓ
1.7 ℓ	4.8 ℓ	9.9 ℓ	14.4 ℓ	13.1 ℓ
37.5 ℓ	42.0 ℓ	86.3 ℓ	91.1 ℓ	72.0 ℓ
58.3 ℓ	121.5 ℓ	134.2 ℓ	124.6 ℓ	105.7 ℓ

49

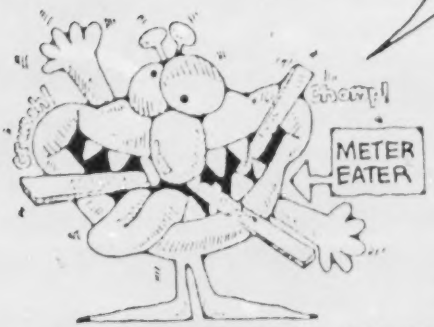


1.7 ℓ	1.5 ℓ	1.3 ℓ	1.7 ℓ	2.6 ℓ
2.8 ℓ	0.1 ℓ	0.1 ℓ	3.6 ℓ	0.7 ℓ
25.6 ℓ	30.9 ℓ	60.7 ℓ	36.6 ℓ	7.9 ℓ
54.9 ℓ	80.8 ℓ	38.5 ℓ	46.6 ℓ	75.8 ℓ
89.8 ℓ	89.2 ℓ	97.5 ℓ	86.9 ℓ	99.6 ℓ

50

the 4th compAny

section 12: decimals: hundredths of liters



Objectives: Given two expressions involving hundredths of a liter, find their sum.

Given two expressions involving hundredths of a liter, find their difference.

Materials: liter, deciliter, and centiliter measures (3 1/2 oz. plastic Solo cups hold 1 dℓ and paper portion control cups can be marked to show 1 cℓ)

Vocabulary: hundredths of a liter, "___ point ___ liters"

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Review decimal numeration, that is, writing consecutive two-place decimals. Turn back to page 31 and have students read the decimals in order. Point out that they are merely consecutive integers with two places to the right of the decimal. Then assign page 51.

2. Turn back to page 28 and review how decimeters and centimeters can be expressed as hundredths of a meter. Explain that, in a similar fashion, deciliters and centiliters can be expressed as hundredths of a liter. Set out 2 dℓ and 3 cℓ and ask if anyone can write it as a decimal: 0.23ℓ. Repeat with five or six examples.

   Then write a decimal on the board and have a volunteer come forward to pick up the corresponding number of dℓ and cℓ containers. Repeat 5 or 6 times.

   Then write these three measures on the board:

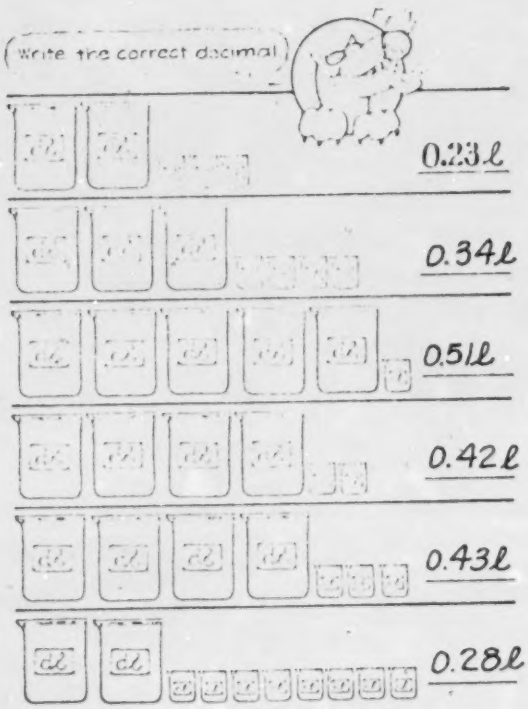
   0.01ℓ 0.10ℓ 1.00ℓ

   Discuss what each means. Ask the class which is the largest amount, which the smallest. Assign page 52.

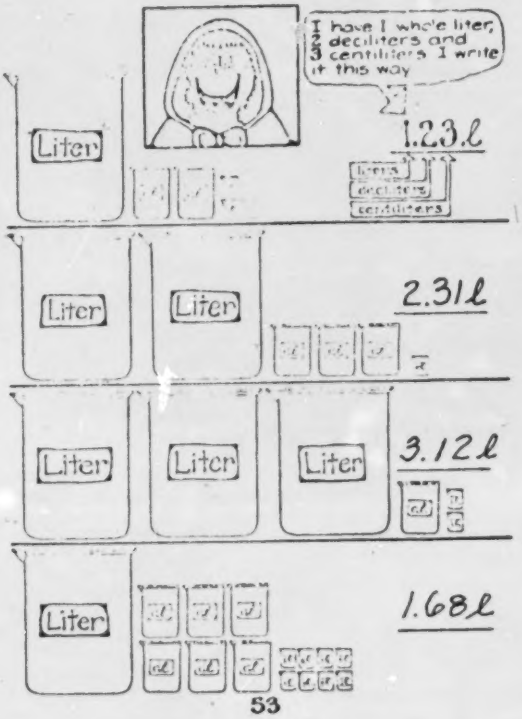
3. Set out 1 liter, 2 dℓ, and 3 cℓ. Ask, "How can I represent these containers?" Write 1.23ℓ on the board. Then assign page 53. Repeat with other examples if necessary

4. Explain that addition and subtraction with two-place decimals, hundredths, is just like addition and subtraction with whole numbers, except that we bring the decimal straight down in the answer. Work several examples on the board, then assign pages 54 and 55.

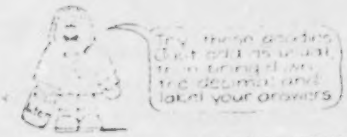
5!



52



53



0.08ℓ	0.07ℓ	0.08ℓ	0.10ℓ	0.15ℓ
0.18ℓ	0.13ℓ	0.38ℓ	0.45ℓ	0.69ℓ
0.87ℓ	0.97ℓ	0.99ℓ	0.64ℓ	0.94ℓ
0.55ℓ	0.95ℓ	0.90ℓ	0.72ℓ	0.90ℓ
1.20ℓ	1.06ℓ	1.34ℓ	1.21ℓ	1.22ℓ
119.95ℓ	89.87ℓ	78.69ℓ	834.93ℓ	46.99ℓ

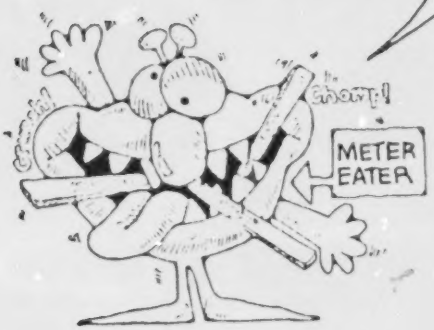
54

0.04ℓ	0.05ℓ	0.04ℓ	0.03ℓ	0.01ℓ
0.06ℓ	0.07ℓ	0.06ℓ	0.09ℓ	0.08ℓ
6.21ℓ	2.02ℓ	2.14ℓ	0.41ℓ	2.53ℓ
0.19ℓ	0.16ℓ	0.25ℓ	3.84ℓ	2.79ℓ
8.58ℓ	12.78ℓ	24.33ℓ	16.12ℓ	25.95ℓ
320.37ℓ	27.00ℓ	553.28ℓ	0.01ℓ	

55

the 4th company

section 13 · mass (weight) : gram · kilogram



Objectives: Given a pull spring scale and mesh bag, determine the mass of an object in grams.

Given a bathroom scale, weigh oneself to the nearest kilogram.

Materials: one-gram weights, balance (optional), pull-type spring scale calibrated in grams and a mesh bag (or a platform scale), stapler, book, unopened can of soup, vitamin bottle or cereal box with milligrams printed on the label, kilogram weight, kilogram bathroom scale

Vocabulary: mass, weight, gram, decigram, centigram, milligram, dekagram, hectogram, kilogram

SUGGESTED PROCEDURE AND ACTIVITIES:

At this level no distinction need be made between mass and weight. The word "weight", as used in this program, means mass. Use the terms interchangeably with your students. Make them familiar with the word "mass" to ease future explanations.

1. Review for the class the basic measurement topics and units you have covered so far. "To measure length the basic metric unit you learned about was the meter." Have the class name some multiples and submultiples of the meter (km, hm, dam, dm, cm, mm). Point out those units used most often, the m, km, cm, and mm. "To measure liquid capacity the basic metric unit you learned about was the liter." Have the class name some multiples and submultiples of the liter (kℓ, hℓ, daℓ, dℓ, cℓ, mℓ). Point out those units used most often, the ℓ and mℓ. Explain, "Now we will learn about the metric units used to measure mass or weight. One of them is the gram." Write "gram" and its symbol "g" on the board. Also write the words "mass" and "weight". Explain that the gram is very light; a paper clip has a mass of about one gram. Hold up a 1-gram weight, either a plastic cube or a brass one (both would be good) and explain that is a 1-gram weight, manufactured to weigh just one gram and to be used with a balance to determine the mass in grams of small objects.

2. Refer to the chart on page 56. Discuss the dekagram, hectogram, and kilogram. If you have snap-together 1-gram weights, connect a couple of them for the class. Ask if anyone can make a dekagram weight using the 1-gram weights. Hopefully, someone will connect 10 of them to make 10 grams or a dag. Ask how a hectogram weight could be made, and a kilogram weight. Explain that the dekagram and the hectogram are rarely used, but the kilogram is very important. Introduce the kilogram weight. Explain that, as they know, "kilo" means 1000, and the kilogram weight has a mass of 1000 grams or 1 kilogram. Pass the weight around so every student can hold it. Explain that the kilogram is used for weighing people, fruit and vegetables, rice, meat, cars, luggage, etc. Ask them what things they think weigh about 1 kg. The following things each have a mass of about 1 kg:

   a quart of milk
   4 lunch milk cartons of milk
   a pair of mens shoes
   6 bananas
   5 medium apples
   a little league baseball bat
   2 footballs.

Have them guess how many of their metric workbooks would weigh one kg. Check that guess and any others on the balance or spring scale.

Direct students to look for items marked in grams and kilograms the next time they go to the grocery store.

3. Have students turn to page 57 and carefully cut out the rectangle labeled "gram". Have them fold it in half a few times so it will fit in one hand. Explain that they are holding approximately one gram of paper. See if the class can find objects which weigh one gram. Use a balance and one-gram weights to check various small items. You might try thumb tacks, paper clips, coins, pieces of candy, etc.

   Students should also cut out the dg, cg, and mg from page 57. Let children balance them on the balance. See if 10 dg will balance a gram, etc.

   Since these units are so light, they are used only by doctors or scientists who need precise measurements. The mg is used in medicines, for example. In daily life the gram and kilogram are used most often.

4. Weigh two small objects on the balance and write their masses in grams on the board. Ask the class what their combined mass would be, that is, if you put both items in the same pan, how many grams would it take to balance them? Write and solve the addition problem involved.

   pencil 9 g
   nickel 5 g
   14 g

   Then place both items on the balance to verify the answer. The weight may be one gram off the expected. Let the class speculate why. It could be due to the fact that each item is 1/2 gram off on the balance, making a combined difference of 1 gram.

5. Assign page 59.

6. Show the class a pull-type spring scale (or platform scale) and explain the calibrations. Demonstrate how to use it by measuring the mass in grams of an object. Point out the need to zero the scale before each weighing. If using the pull-type scale, you may want to hang it on a nail or hook to reduce swinging. Also, when using a pull-type scale you will need a mesh bag or similar arrangement to contain the object being weighed.

   Discuss the calibrations on the scales on page 60. Then assign pages 60 and 61. For page 61 set up a weighing station with a scale and three things to weigh: a stapler, a book, and an unopened can of soup. Let pairs of students determine the mass of each item and record on page 61.

7. Once again discuss the units of mass which are most commonly used. Explain that hg, dag, dg, and cg are almost never used, but that milligrams are used extensively in medicine and other sciences. Pass around a vitamin bottle or cereal box with listings of vitamins in mg. Note that frequently improper symbols are used for milligram and gram. Warn students that they may see any of the following:

gm. for gram	MG. for milligram
gms. for grams	mgs. for milligrams
Gm for grams	

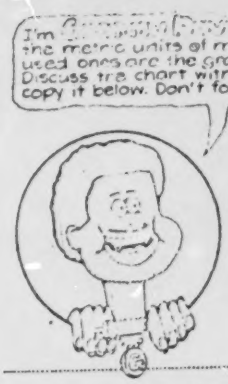
   Remind them that the only proper symbols, however, are "g" for gram and "mg" for milligram, always lower case and with no period (unless they end a sentence, of course). Point these out on the chart on page 56.

8. Assign pages 62 and 63. Students are to draw lines to connect the objects with the unit most appropriate for measuring its mass. Page 63 is a secret code.

9. Introduce the kilogram bathroom scale. Explain that each long line represents one kilogram and each short line is half a kilogram. If your scale is calibrated in both pounds and kilograms, point this out to the students. Direct them to ignore the pound calibrations at this time.

10. Assign pages 64 and 65. While the rest of class works at their seats, have students come one or two at a time to weigh themselves on the bathroom scale. Supervise. They can record their results on page 65.

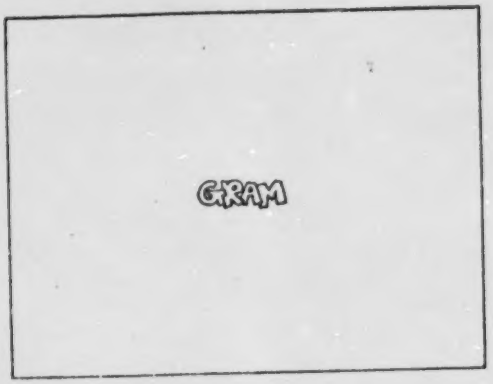
11. Make a bulletin board display with labels from the supermarket. Have each student bring at least one label from home.


I'm [illegible] here to present the metric units of mass. The most commonly used ones are the gram, kilogram, and milligram. Discuss the chart with your classmates then copy it below. Don't forget the symbols.

1000	kilogram (kg)
100	hectogram (hg)
10	dekagram (dag)
1	gram (g)
0.1	decigram (dg)
0.01	centigram (cg)
0.001	milligram (mg)

1000	kilogram	(kg)
100	hectogram	(hg)
10	dekagram	(dag)
1	gram	(g)
0.1	decigram	(dg)
0.01	centigram	(cg)
0.001	milligram	(mg)

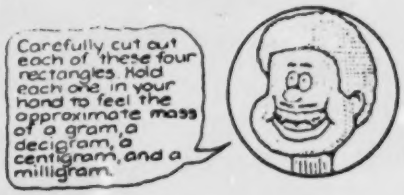
56



dg

cg

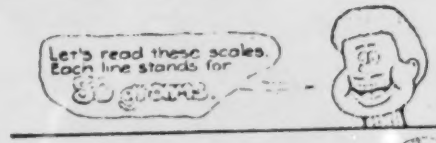
mg

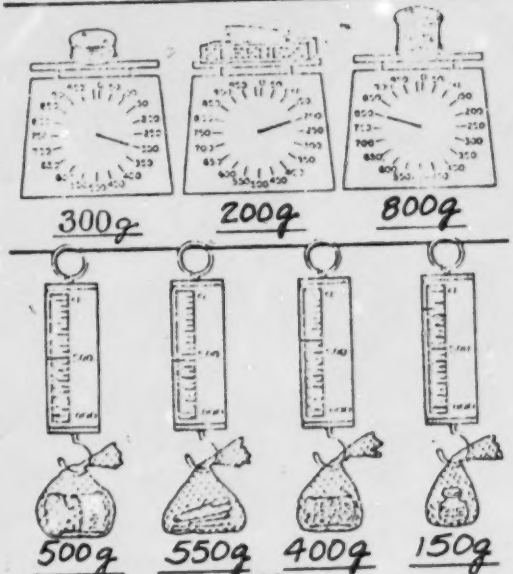

Carefully cut out each of these four rectangles. Hold each one in your hand to feel the approximate mass of a gram, a decigram, a centigram, and a milligram.

57

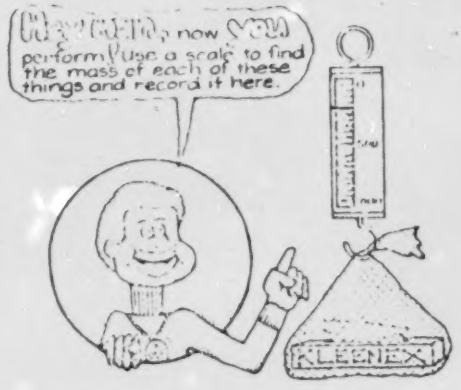
68g + 31g = 99g	41g + 37g = 78g	76g + 22g = 98g	55g + 14g = 69g	37g + 52g = 89g
263g + 124g = 387g	390g + 207g = 597g	468g + 327g = 795g	539g + 328g = 867g	608g + 522g = 1130g
487g + 634g = 1121g	512g + 835g = 1110g	349g + 289g = 638g	206g + 6g = 212g	999g + 100g = 1099g
384g + 616g = 1000g	287g + 13g = 300g	542g + 58g = 600g	500g + 500g = 1000g	450g + 550g = 1000g
1028g + 2938g = 3966g	3620g + 1430g = 5050g	9862g + 73g = 9935g	1764g + 889g = 2653g	5482g + 988g = 6470g

59





60

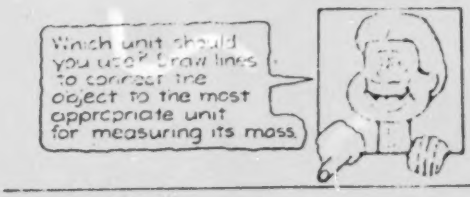


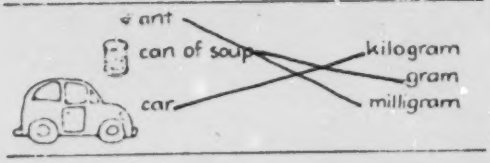
stapler about ____ g

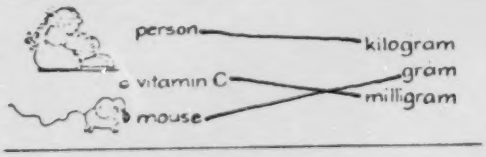
small book about ____ g

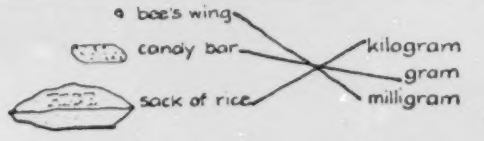
can of soup about ____ g

G1









G2

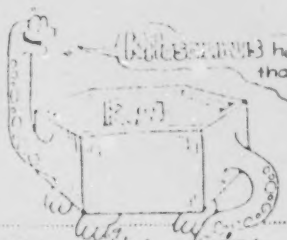
I	N
34 kg +33 kg	50 g -15 g
67kg	35g

G	R	A	M
21 g +21 g	17 kg +18 kg	66 mg -24 mg	93 mg -23 mg
42g	35kg	42mg	67mg

F	R	A	N	C	I	S	C	O
36 kg + 6 kg	26 kg + 9 kg	81 mg -39 mg	70 g -35 g	28 g +39 g	60 kg + 7 kg	99 mg -64 mg	89 g -22 g	73 mg +27 mg
42kg	35kg	42mg	35g	67g	67kg	35mg	67g	100mg

G3

G4



45 kg + 45 kg = 90 kg	100 kg − 75 kg = 25 kg	37 kg + 26 kg = 63 kg	84 kg − 37 kg = 47 kg	35 kg + 35 kg = 70 kg
50 kg − 25 kg = 75 kg	17 kg + 17 kg = 34 kg	75 kg − 25 kg = 50 kg	42 kg + 38 kg = 80 kg	50 kg + 50 kg = 100 kg
60 kg − 48 kg = 12 kg	49 kg + 49 kg = 98 kg	72 kg − 36 kg = 36 kg	23 kg + 37 kg = 60 kg	90 kg − 45 kg = 45 kg
27 kg + 28 kg = 55 kg	56 kg − 28 kg = 28 kg	98 kg + 25 kg = 123 kg	48 kg + 19 kg = 67 kg	81 kg − 58 kg = 23 kg

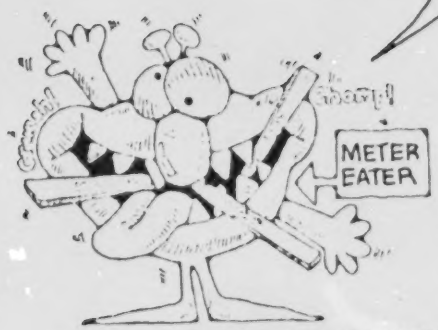
Find your own mass in kilograms.

I weigh about _____ kilograms.

65

the 4th company

section 14 · perimeter



Objectives: Given polygons with lengths of sides labeled, determine the perimeter (to the nearest cm).

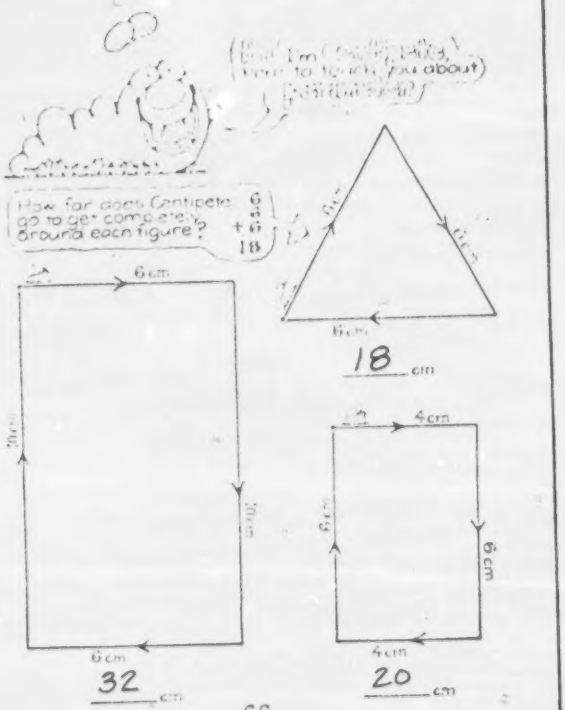
Given a centimeter ruler, determine the perimeter of polygons (to the nearest centimeter).

Materials: cm rulers

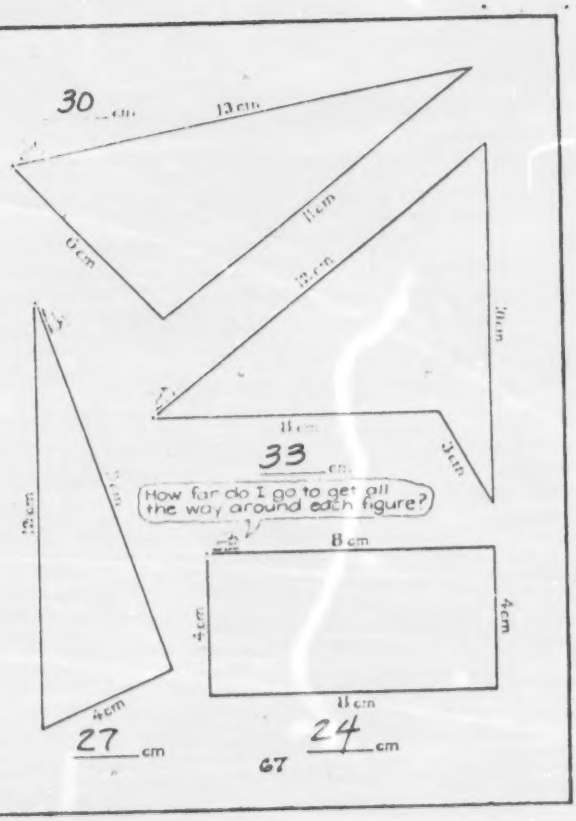
Vocabulary: perimeter

SUGGESTED PROCEDURE AND ACTIVITIES:

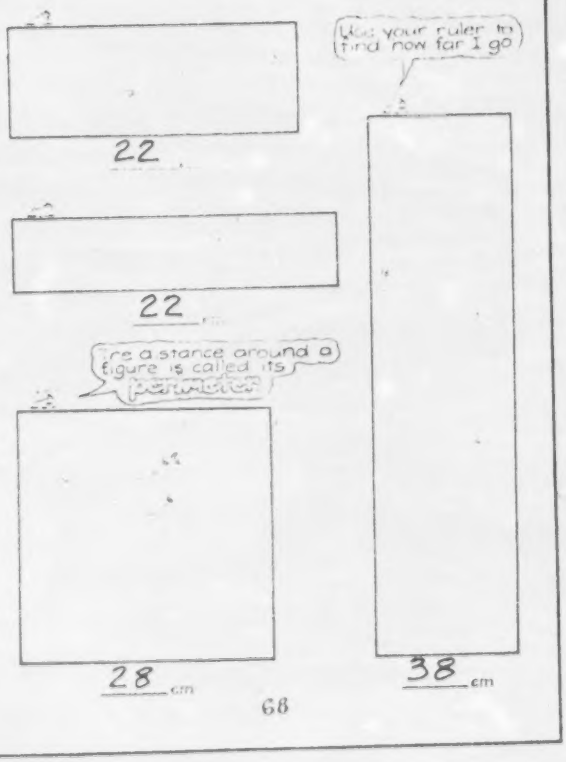
1. Draw a triangle on the board and use a ruler to find the length of each side. Then add them up to determine the perimeter.
2. Discuss, then assign pages 66, 67, 68, and 69.
3. For additional practice, have students find the perimeters of books in the classroom. Or measure the perimeter of the chalkboard.


How far does Centipete go to get completely around each figure?
6
6
+6
18
6cm
6cm
6cm
18 cm
6cm
30cm
6cm
32 cm
4cm
6cm
6cm
4cm
20 cm

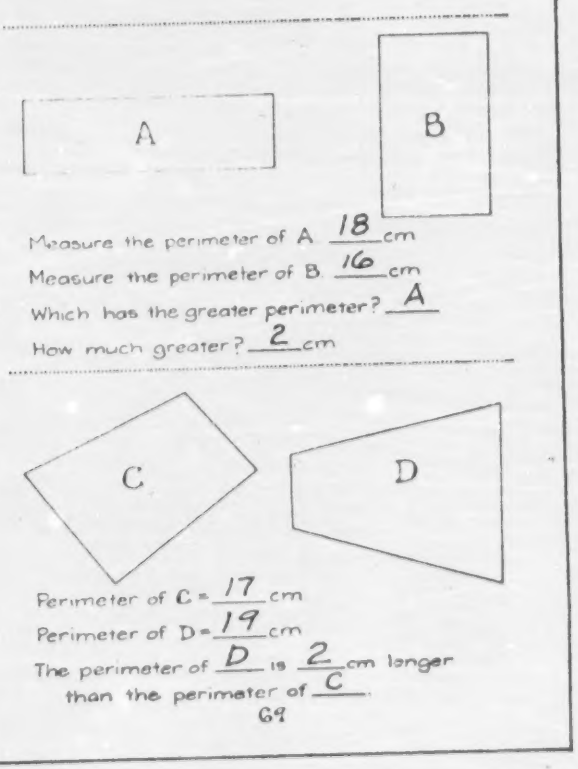
66


30 cm
13cm
11cm
12cm
11cm
33 cm
How far do I go to get all the way around each figure?
13cm
4cm
27 cm
8 cm
4cm
4cm
11cm
24 cm

67


22
Use your ruler to find how far I go
22
It's a stance around a figure is called its perimeter
28 cm
38 cm

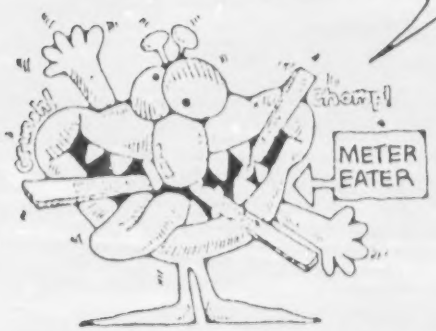
68


A
B
Measure the perimeter of A 18 cm
Measure the perimeter of B 16 cm
Which has the greater perimeter? A
How much greater? 2 cm
C
D
Perimeter of C = 17 cm
Perimeter of D = 19 cm
The perimeter of D is 2 cm longer than the perimeter of C.

69

the 4M company

section 5 · area: square centimeter · square decimeter · square meter



Objectives: Given illustrations of rectangles with centimeter rulers along the sides, determine the areas by multiplying.

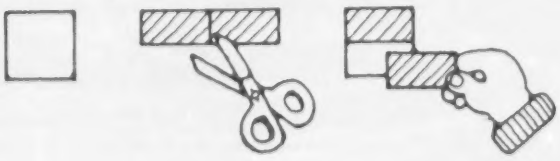
Materials: the following shapes cut from different colored paper: 2 squares (10 cm x 10 cm), 1 square (15 cm x 15 cm), 1 circle (radius 7.5 cm), 1 rectangle (5 cm x 20 cm) (Patterns for these appear on page 67 of the Teacher's Guide.)

Vocabulary: square centimeter, square decimeter, square meter, area

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Before class cut the following from different colored construction paper: 2 squares (10 cm on a side), 1 square (15 cm), 1 circle (radius 7.5 cm), 1 rectangle (5 cm x 20 cm) (Trace the patterns on page 67 if you wish.) For the class hold a large and small square side by side. Explain that the larger one has more area than the smaller. Place the smaller on top of the larger to show that it will not cover the total surface of the larger. Then make these comparisons in the same manner: large square and circle, small square and circle.

   Then compare the 2 small squares. Students should see that they have the same area. Finally compare the rectangle with a small square. They have the same area. Demonstrate this by cutting the rectangle in two and fitting the pieces on the square. Point out that for two figures to have the same area, they need not always have the same shape.



2. Assign page 70. If students have difficulty comparing areas by sight alone, suggest they trace the shapes, cut them out, and make direct comparisons.

3. Do page 71 as a group. Shape B is to be cut out and placed on shape A to compare areas.

4. Introduce the square centimeter. Explain that it is not enough to just tell that one area is larger than another. We need a way to determine how large it is, that is, how to measure it. We need a unit. Have the class turn to page 73. Point out the square centimeters in the upper right hand corner. Measure one for the class to show it is 1 cm on each side. Have students cut out their square cm and do page 73 together.

5. Assign page 74. Students are to count the square cm to determine the areas.

6. Have students turn to page 75. Discuss the short cut for finding area. Assign pages 75, 76, and 77. On pages 76 and 77 students are to read the measures and multiply. They may verify their answers by connecting the dots to make a grid of square cm to count.

   Assign pages 78 and 79. Students are to use their own rulers to measure the sides of the figures, then multiply.

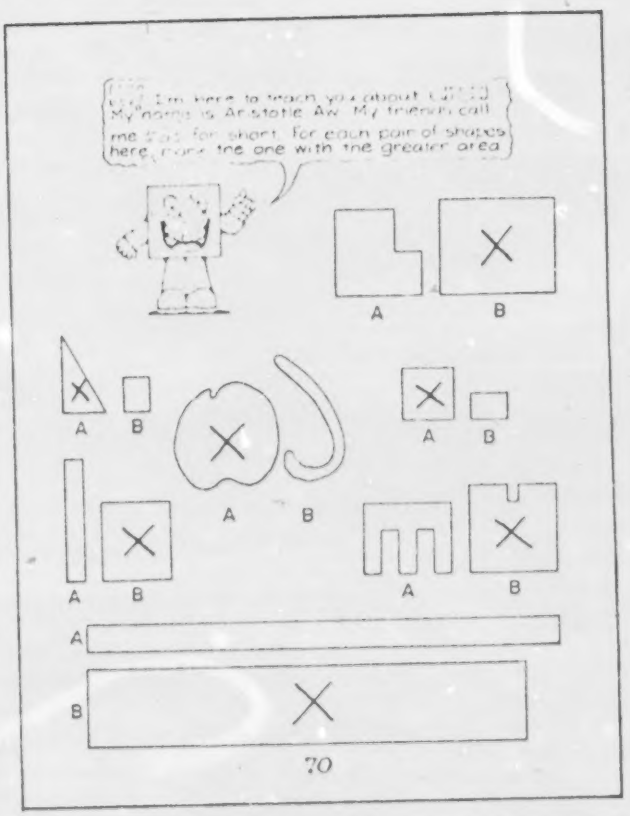
7. Explain to the class that for larger areas, we use larger square units. Have them turn to page 81 of their booklets

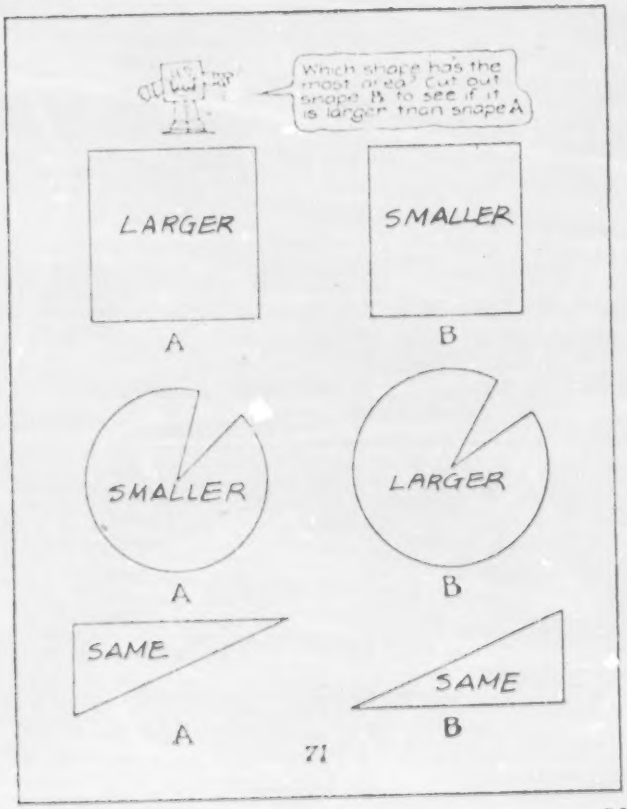
where there is drawn a square decimeter. Measure one for the class to show it is 1 dm on each side. Have students cut them out. As an activity have the class guess the area of a small table in square dm, then cover it with their squares to check.

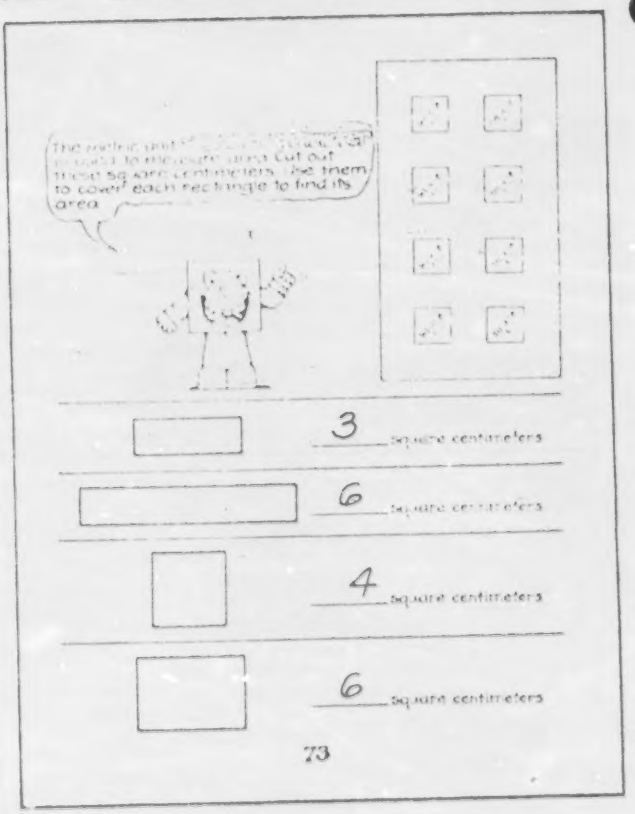
8. On a bulletin board mark off 1 square meter with string or yarn. Explain to the class that for very large areas, like the area of the classroom floor, we use the square meter. Point out the square meter you have made on a bulletin board. Measure it for the class to show it is 1 m on each side. Have the class guess how many square dm it would take to cover 1 square meter. As an activity have everyone decorate their square dm, then one by one thumb tack them inside the square meter.

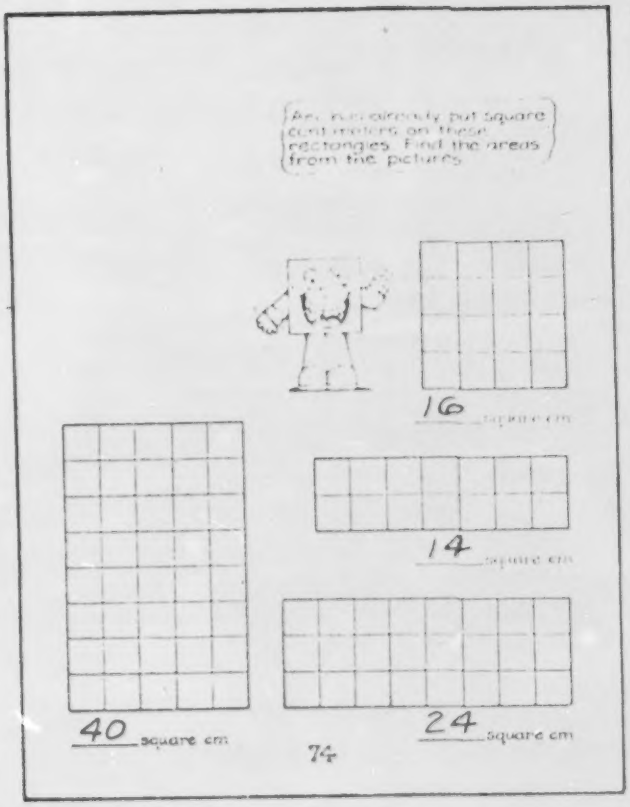
9. Have students guess the area in square meters of the classroom floor. Measure and multiply to see whose guess was the closest.

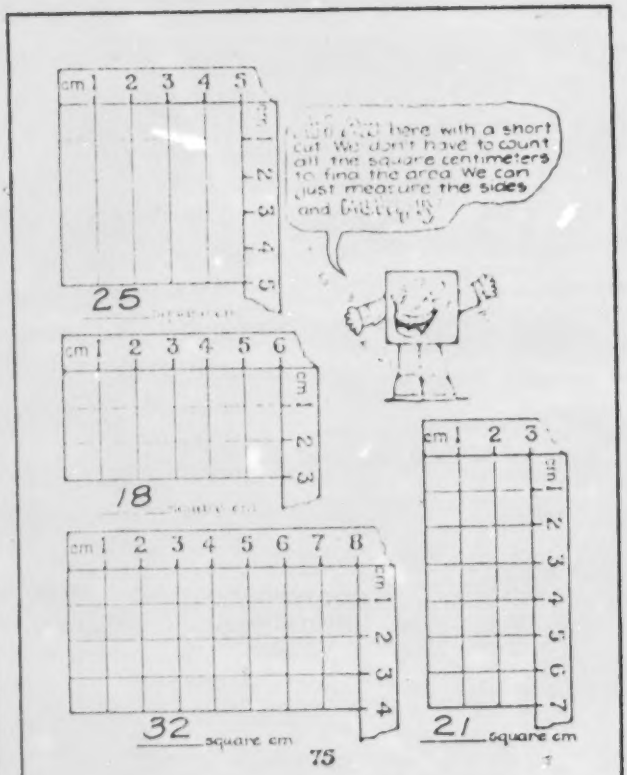
10. Assign page 80.

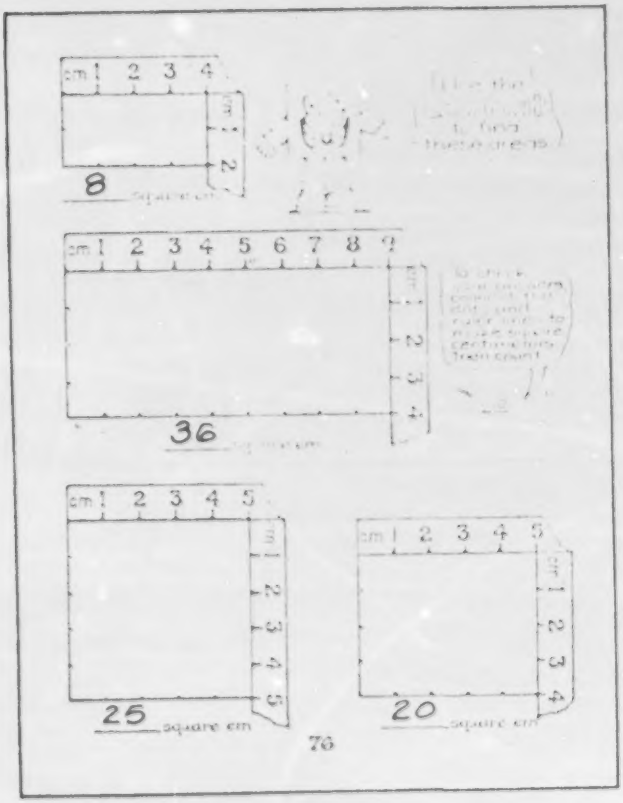

I'm here to teach you about [illegible]. My name is Aristotle Aw. My friends call me [illegible] for short. For each pair of shapes here, mark the one with the greater area
A
B
70

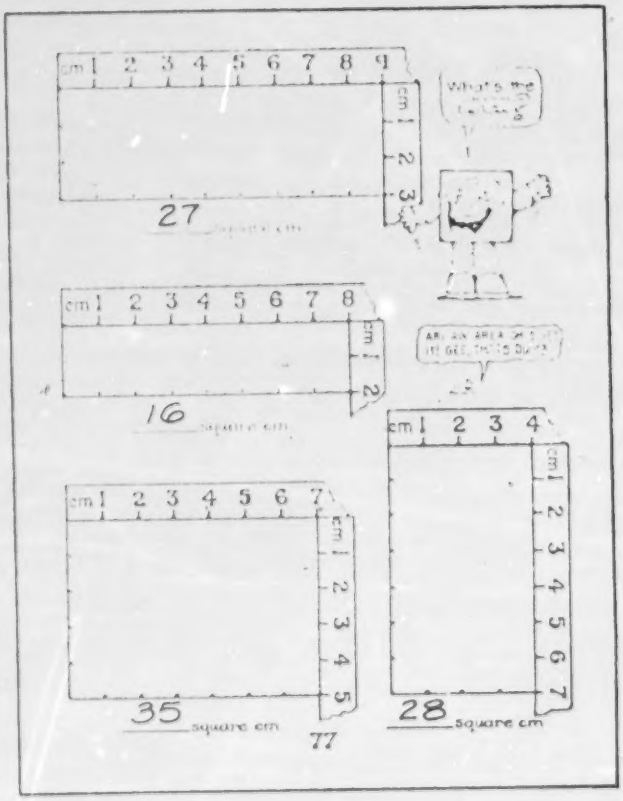



[illegible] Cut out these squares centimeters. Use them to cover each rectangle to find its area
3 square centimeters
6 square centimeters
4 square centimeters
6 square centimeters
73

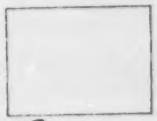

Art cut correctly put square centimeters on these rectangles. Find the areas from the pictures.
16 square cm
14 square cm
40 square cm
24 square cm
74


cm 1 2 3 4 5
25 square cm
cm 1 2 3 4 5 6
18 square cm
cm 1 2 3 4 5 6 7 8
32 square cm
cm 1 2 3
21 square cm
75


cm 1 2 3 4
8 square cm
cm 1 2 3 4 5 6 7 8 9
36 square cm
cm 1 2 3 4 5
25 square cm
cm 1 2 3 4 5
20 square cm
76


cm 1 2 3 4 5 6 7 8 9
27 square cm
cm 1 2 3 4 5 6 7 8
16 square cm
cm 1 2 3 4 5 6 7
35 square cm
cm 1 2 3 4
28 square cm
77

Use your ruler to measure the sides and find the areas.



20 square cm

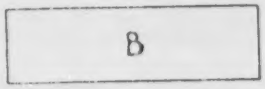
12 square cm

100 square cm

30 square cm

78

A

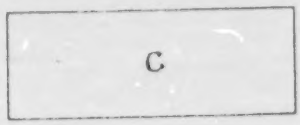


B

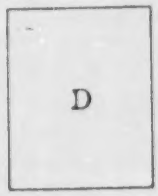
Area of A = 25 square cm

Area of B = 14 square cm

The area of A is 11 square cm greater than the area of B



C



D

Area of C = 24 square cm

Area of D = 20 square cm

The area of C is 4 square cm greater than the area of D

79

Secret Code:

G	25 square cm
A	25 square cm
I	25 square cm
R	34 square cm
S	34 square cm
H	38 square cm
Y	79 square cm
E	79 square cm
T	79 square cm

Try this.

A	R	I
11 square dm +14 square dm 25 square dm	17 square cm +17 square cm 34 sq.cm	50 square mm 75 square mm 25 sq.m

G	E	T	S
37 square cm -12 square cm 25 sq.cm	35 square dm +15 square dm 79 sq.dm	90 square m -11 square m 79 sq.m	70 square dm -36 square dm 34 sq.dm

H	A	I	R	Y
59 square m -18 square m 34 sq.dm	14 square cm +11 square cm 25 sq.dm	20 square m + 5 square m 25 sq.m	76 square cm -42 square cm 34 sq.cm	46 square cm +33 square cm 79 sq.cm

80

60

SECTION 2: decimeter strips (make one per student)

dm
dm
dm
dm
dm
dm
dm
dm
dm
dm
dm
dm
dm
dm
dm
dm
dm
dm

61

dm
dm
dm
dm
dm
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dm
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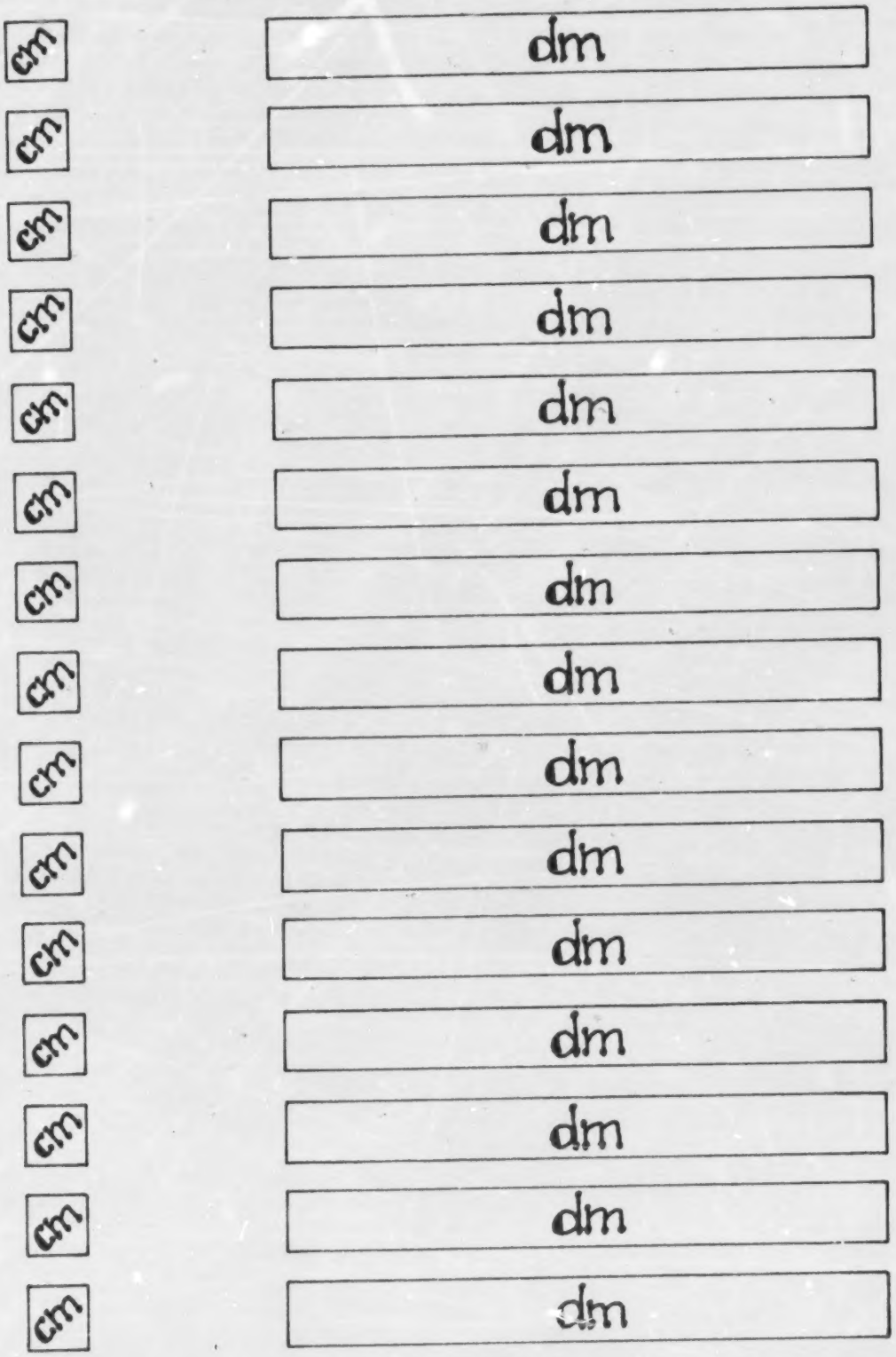
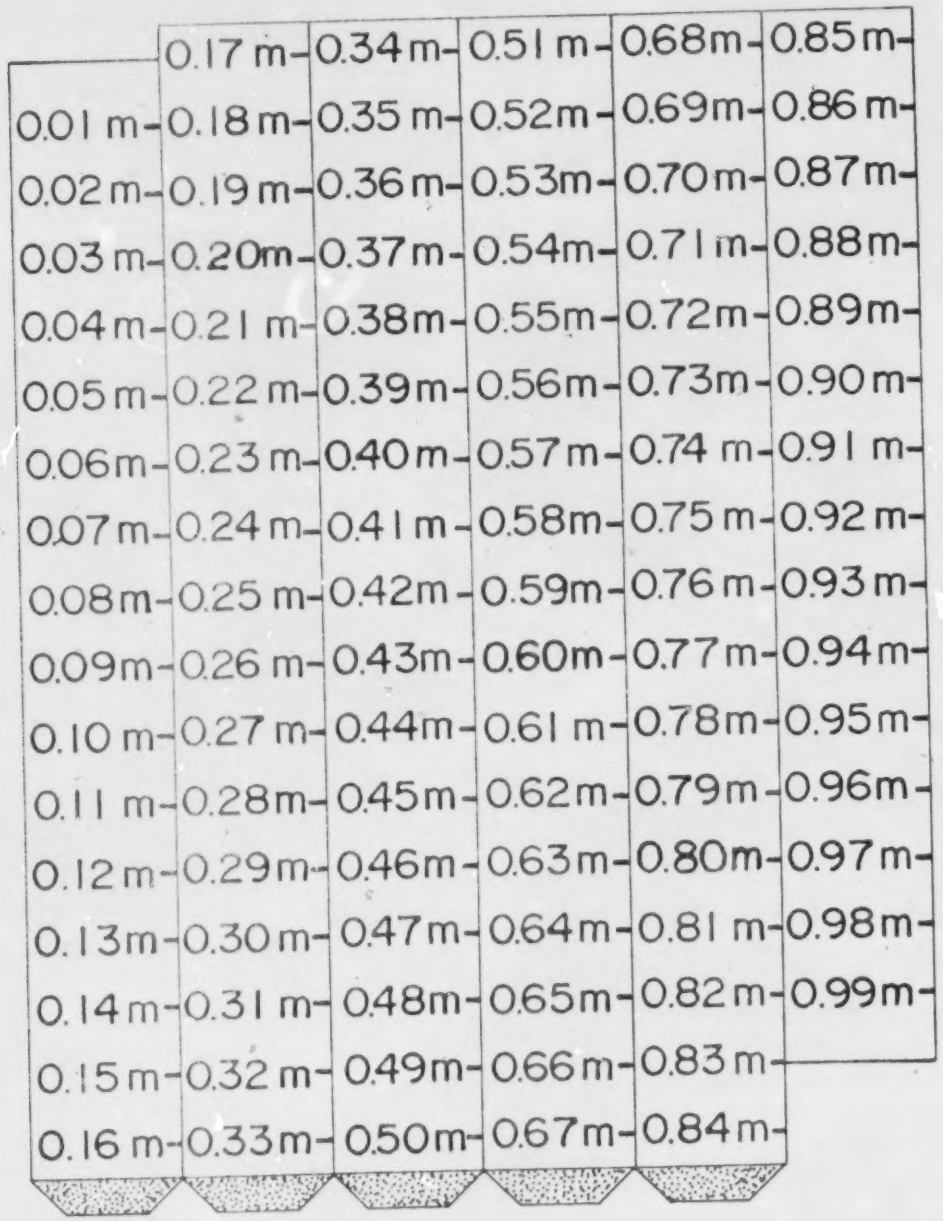
dm
dm
dm
dm
dm

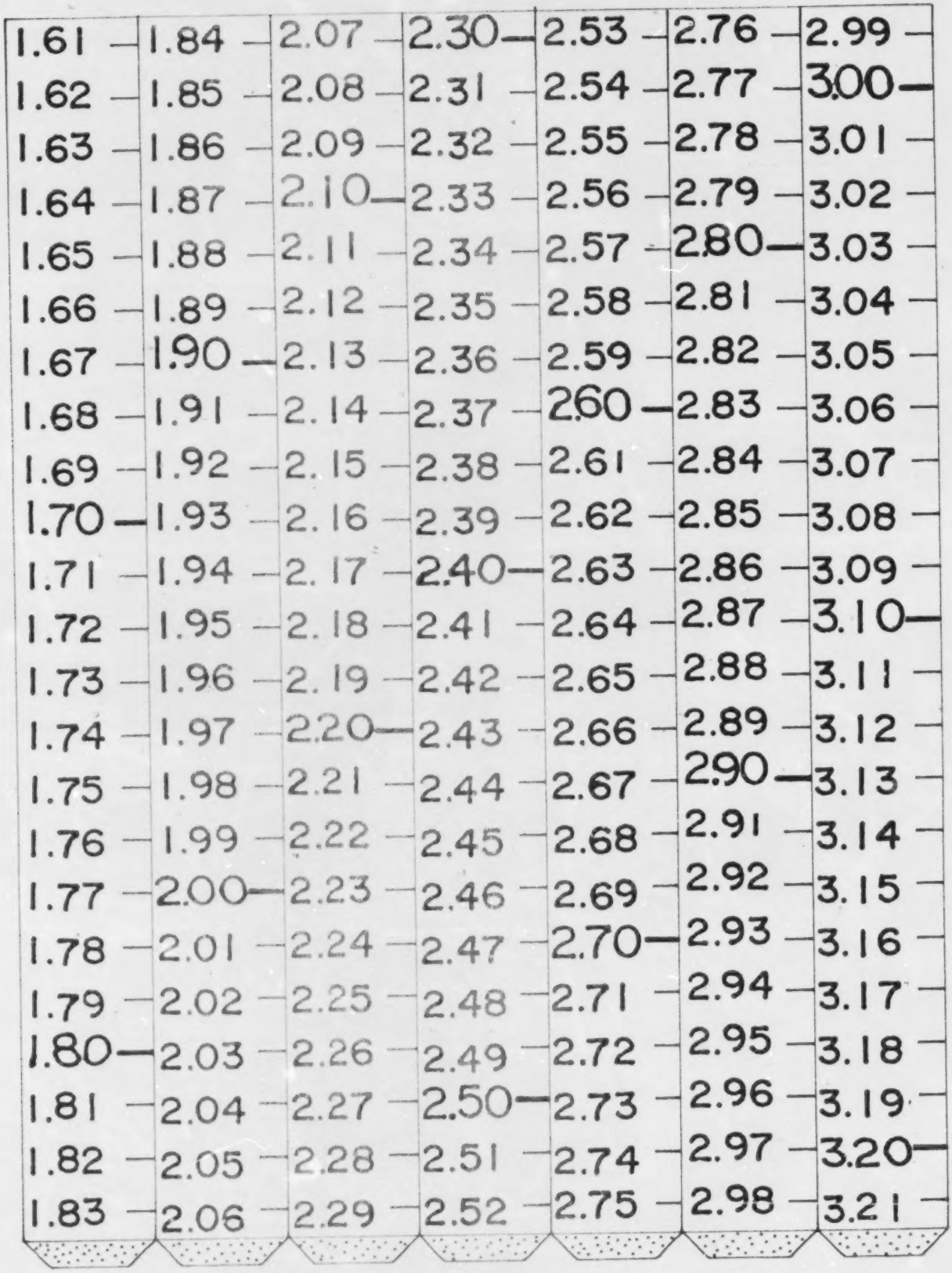
SECTION 6: centimeter strips SECTION 4, 5, 6, 7, 8: decimeter strips



SECTION 6. Cut out strips and tape together to make a "hundredths ruler" 1 meter long.



	0.23	0.46	0.69	0.92	1.15	1.38
0.01	0.24	0.47	0.70	0.93	1.16	1.39
0.02	0.25	0.48	0.71	0.94	1.17	1.40
0.03	0.26	0.49	0.72	0.95	1.18	1.41
0.04	0.27	0.50	0.73	0.96	1.19	1.42
0.05	0.28	0.51	0.74	0.97	1.20	1.43
0.06	0.29	0.52	0.75	0.98	1.21	1.44
0.07	0.30	0.53	0.76	0.99	1.22	1.45
0.08	0.31	0.54	0.77	1.00	1.23	1.46
0.09	0.32	0.55	0.78	1.01	1.24	1.47
0.10	0.33	0.56	0.79	1.02	1.25	1.48
0.11	0.34	0.57	0.80	1.03	1.26	1.49
0.12	0.35	0.58	0.81	1.04	1.27	1.50
0.13	0.36	0.59	0.82	1.05	1.28	1.51
0.14	0.37	0.60	0.83	1.06	1.29	1.52
0.15	0.38	0.61	0.84	1.07	1.30	1.53
0.16	0.39	0.62	0.85	1.08	1.31	1.54
0.17	0.40	0.63	0.86	1.09	1.32	1.55
0.18	0.41	0.64	0.87	1.10	1.33	1.56
0.19	0.42	0.65	0.88	1.11	1.34	1.57
0.20	0.43	0.66	0.89	1.12	1.35	1.58
0.21	0.44	0.67	0.90	1.13	1.36	1.59
0.22	0.45	0.68	0.91	1.14	1.37	1.60


1.61
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1.73
1.74
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3.01
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3.10
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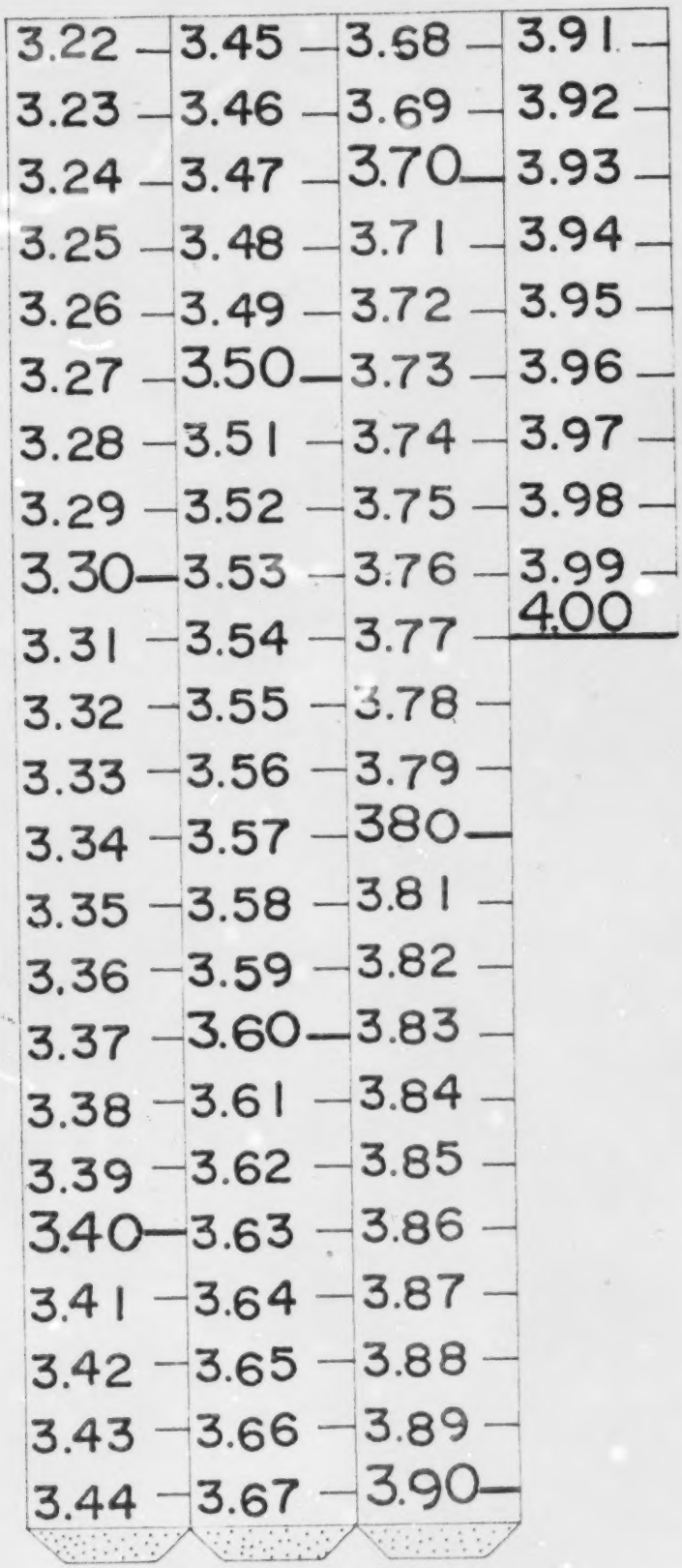
3.19
3.20
3.21


3.22
3.23
3.24
3.25
3.26
3.27
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3.34
3.35
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3.72
3.73
3.74
3.75
3.76
3.77
3.78
3.79
380
3.81
3.82
3.83
3.84
3.85
3.86
3.87
3.88
3.89
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3.93
3.94
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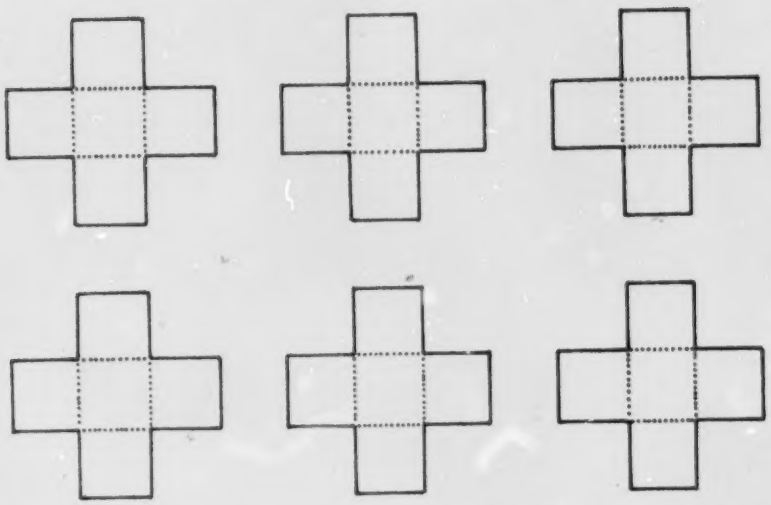
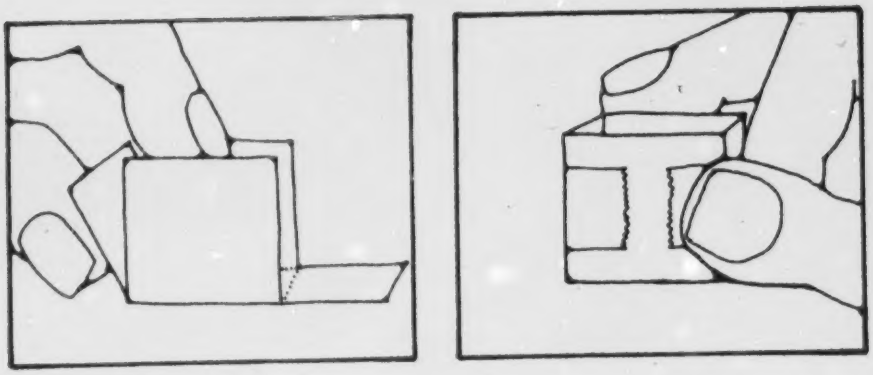
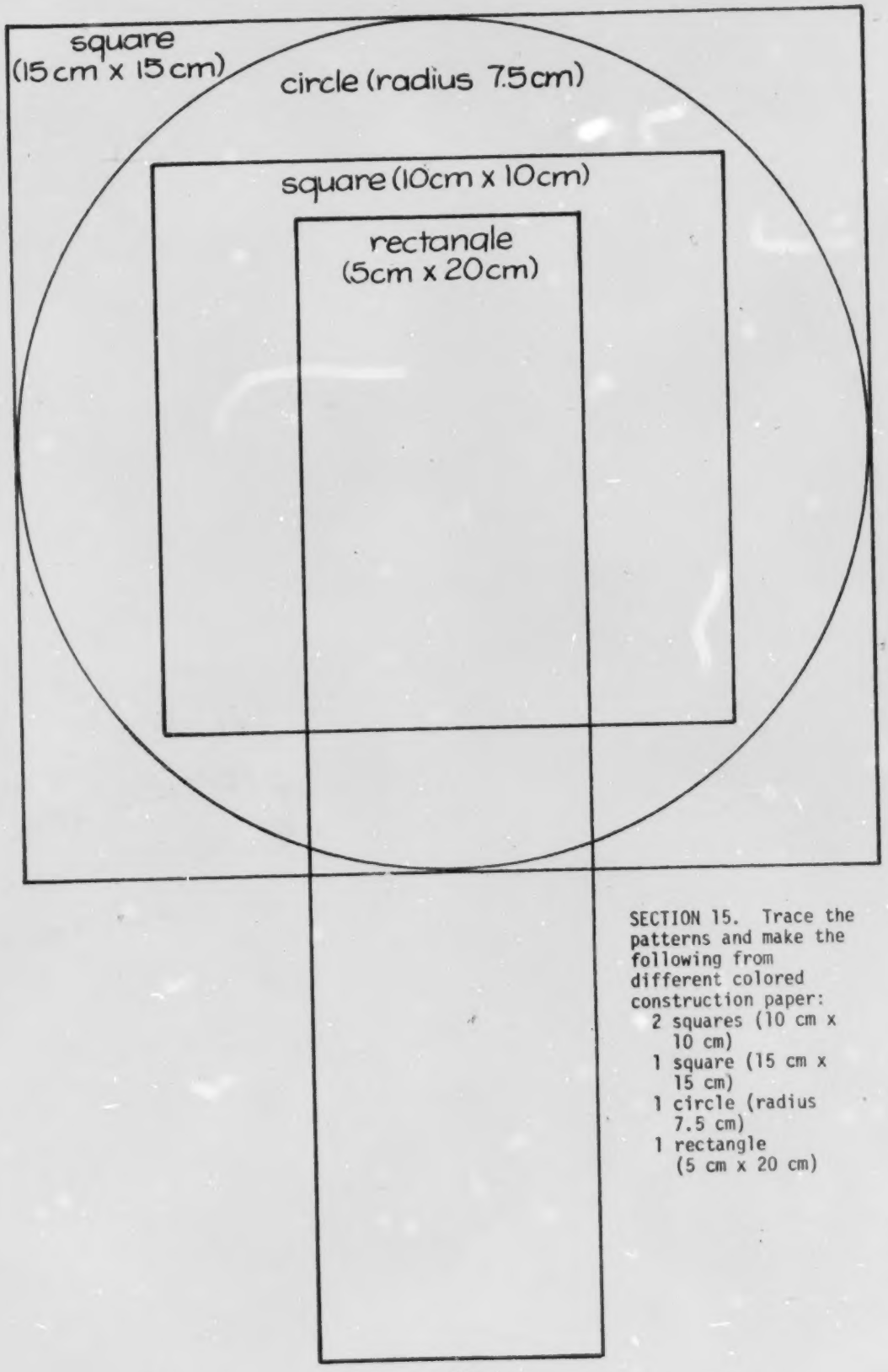
3.96
3.97
3.98
3.99
4.00

SECTION 10. Cut out (or trace) a pattern below. Fold on the dotted lines and tape the sides to make a box. This box will hold 1 milliliter.

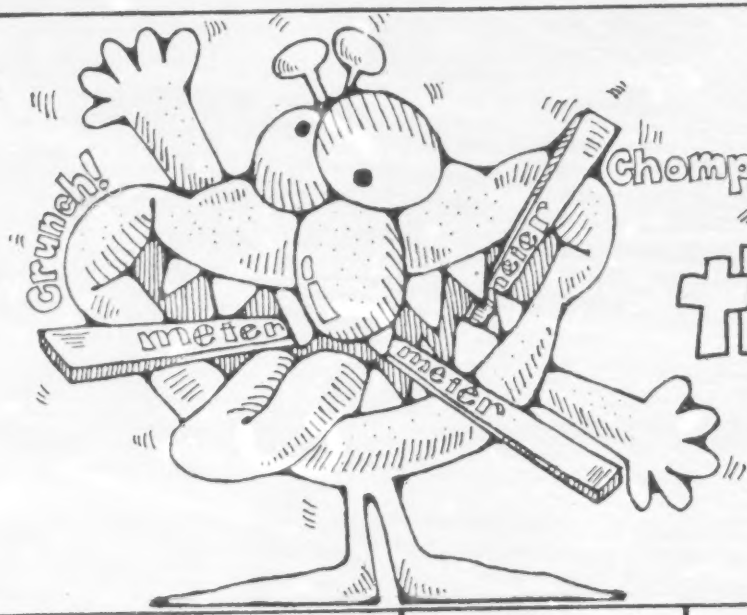






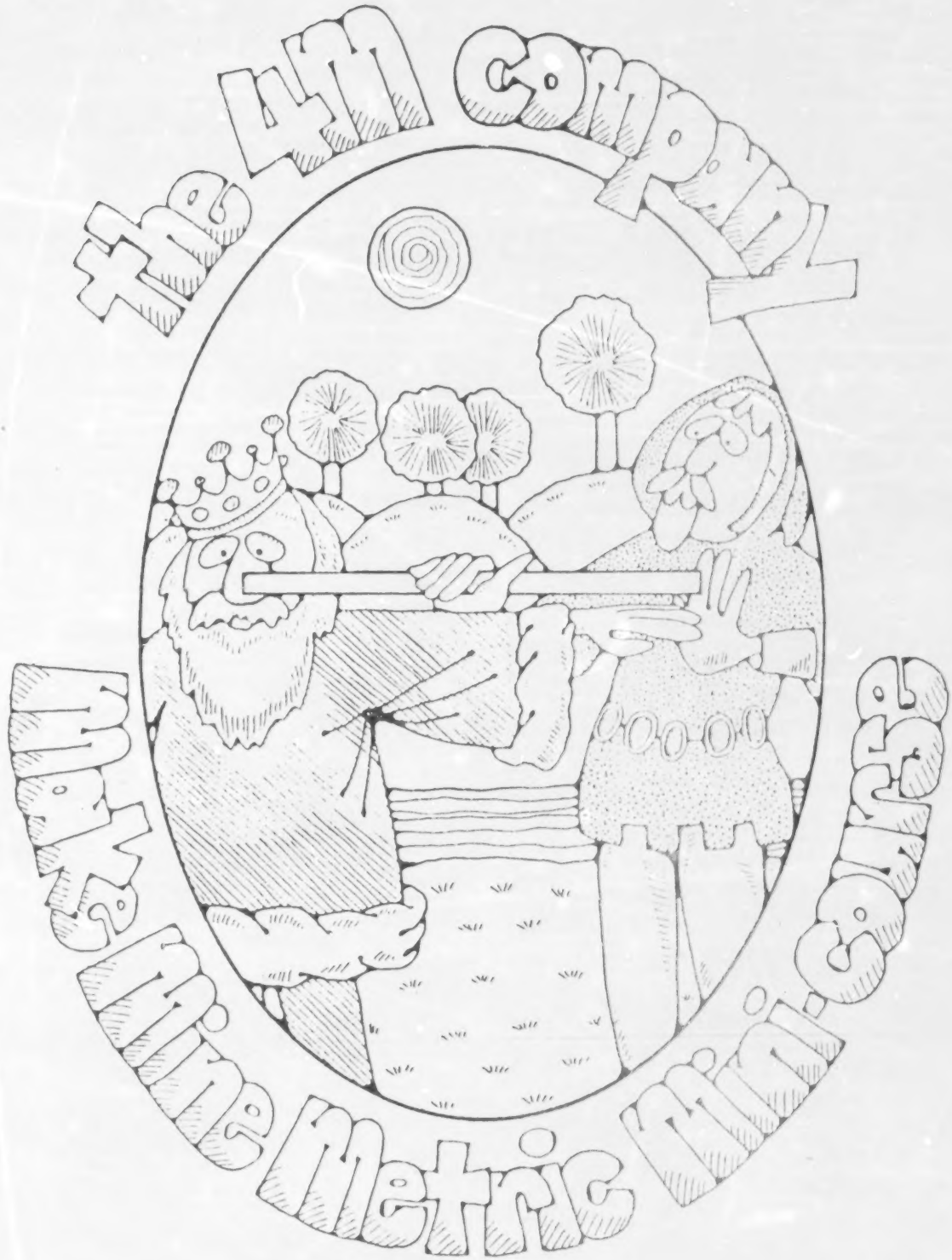
SECTION 15. Trace the patterns and make the following from different colored construction paper:

- 2 squares (10 cm x 10 cm)
- 1 square (15 cm x 15 cm)
- 1 circle (radius 7.5 cm)
- 1 rectangle (5 cm x 20 cm)



Learn the Metric System

1000	kilometer (km)	kiloliter (kl)	kilogram (kg)
100	hectometer (hm)	hectoliter (hl)	hectogram (hg)
10	dekameter (dam)	dekaliter (dal)	dekagram (dag)
1	meter (m)	liter (l)	gram (g)
0.1	decimeter (dm)	deciliter (dl)	decigram (dg)
0.01	centimeter (cm)	centiliter (cl)	centigram (cg)
0.001	millimeter (mm)	milliliter (ml)	milligram (mg)



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Curriculum Research and Development Group

INTRODUCTION

This mini-course is designed to serve two purposes: 1) a quick review of metrics for teachers who have attended a metric workshop; and 2) a basic introduction to the metric system for teachers who have not attended a metric workshop. If studied seriously, we feel the contents of this mini-course can prepare a teacher to teach the metric system. However, don't expect to be an expert right away. Even teachers who have attended a workshop frequently forget much of what they learned. As most teachers know, we usually don't know a subject well until we have taught it a time or two. The same will be true of metrics.

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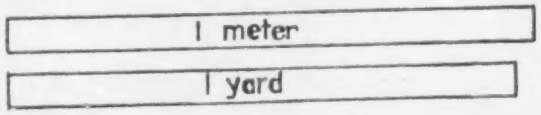
LESSON 1: THE METER, THE LITER, AND THE GRAM

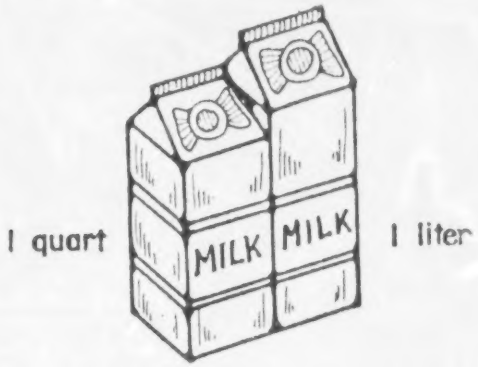
The three most common metric units are the meter (for measuring length or distance), the liter (for measuring liquid or granular capacity), and the gram (for measuring weight). Select a meter, a liter, and a gram from your metric supplies.

The meter is the main unit of length in the metric system. Stand up and hold the meter stick on the floor against your leg. How high up your leg does it come? To your hip? To your waist? Remember the spot and you'll always have some idea of a meter. A meter is just a little longer than a yard -- 39.36 inches.

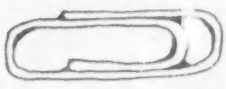


The liter is the main unit of capacity in the metric system. It was originally defined to be the capacity of a cube each of whose sides was 1/10th of a meter long.

Take a good look at the liter. Does it appear to be about the size of any English unit? Actually, the liter is slightly larger than a quart (6% larger, to be exact).



Now pick up the gram, the main unit of weight in the metric system. Pretty light, isn't it? If you look at the protein, fat, and carbohydrate content of the sides of cereal boxes you'll notice that the weights are given in grams. A paper clip weighs about one gram. A nickel weighs 5 grams.



weighs 1 gram

weighs 5 grams

These three units - meter, liter, and gram - are the heart of the metric system necessary for everyday measuring. Try to remember the size of each unit: the meter is a little longer than one yard; a liter is a little larger than a quart; and a gram is the weight of a paper clip.

LESSON 2: OTHER UNITS - PRESTO!

In the English system of measurement there are 14 units of length, and there is no systematic relationship between them:

12 inches = 1 foot

3 feet = 1 yard

5½ yards = 1 rod

40 rods = 1 furlong

8 furlongs = 1 mile

etc.

One would have to be a near-genius to remember all the relationships in the English system!

By comparison, the metric system is simple (although it may not seem so at first). In the metric system there is one base unit for each physical property to be measured. To form units larger or smaller than the base units, a system of prefixes, each of which is a power of ten, is used. For units smaller than the base units, the Latin words for tenth, hundredth, and thousandth are used (deci, centi, and milli). To form units larger than the base units, the Greek words for ten, hundred, and thousand are used (deka, hecto, and kilo). The new units are formed by placing the prefixes in front of the base units.

	LENGTH	CAPACITY	MASS (WEIGHT)
1000	kilometer (km)	kiloliter (kℓ)	kilogram (kg)
100	hectometer (hm)	hectoliter (hℓ)	hectogram (hg)
10	dekameter (dam)	dekaliter (daℓ)	dekagram (dag)
1	meter (m)	liter (ℓ)	gram (g)
0.1	decimeter (dm)	deciliter (dℓ)	decigram (dg)
0.01	centimeter (cm)	centiliter (cℓ)	centigram (cg)
0.001	millimeter (mm)	milliliter (mℓ)	milligram (mg)

Whenever kilo is heard, we know immediately that we have 1000 of the base unit, whatever it is. Thus, kilometer is 1000 meters, kiloliter is 1000 liters, kilowatt is 1000 watts, etc. (The watt is a unit of power.) Or, millimeter is 0.001 meter, milliliter is 0.001 liter, etc.

The writing of metric units is simplified by the use of symbols: m stands for milli, c for centi, d for deci, da for deka (the a is needed to distinguish deci from deka, both of which start with d), h for hecto, and k for kilo. Also, m for meter, ℓ for liter, and g for gram. Thus kg is kilogram, mℓ is milliliter, etc. In the next lesson you will practice using these metric prefixes.

LESSON 3: PRACTICE WITH PREFIXES

In this lesson you will practice using metric prefixes. Use the table in Lesson 2 to help you complete the following equations. Answers appear at the end of the Teacher's Guide.

100 grams = hectogram

10 liters = _____

1000 meters = _____

0.001 gram = _____

100 liters = _____

0.01 gram = _____

0.001 meter = _____

0.01 meter = _____

0.001 liter = _____

100 liters = _____

1000 liters = _____

1000 grams = _____

10 meters = _____

0.1 meter = _____

0.1 liter = _____

0.01 liter = _____

0.1 gram = _____

10 grams = _____

Keep going! Try these!

10 cards = dekacards (get it?)

0.1 Arnaz = _____

0.01 mentalist = _____

1000 manjaros = _____

0.001 tary = _____

0.1 mate = _____

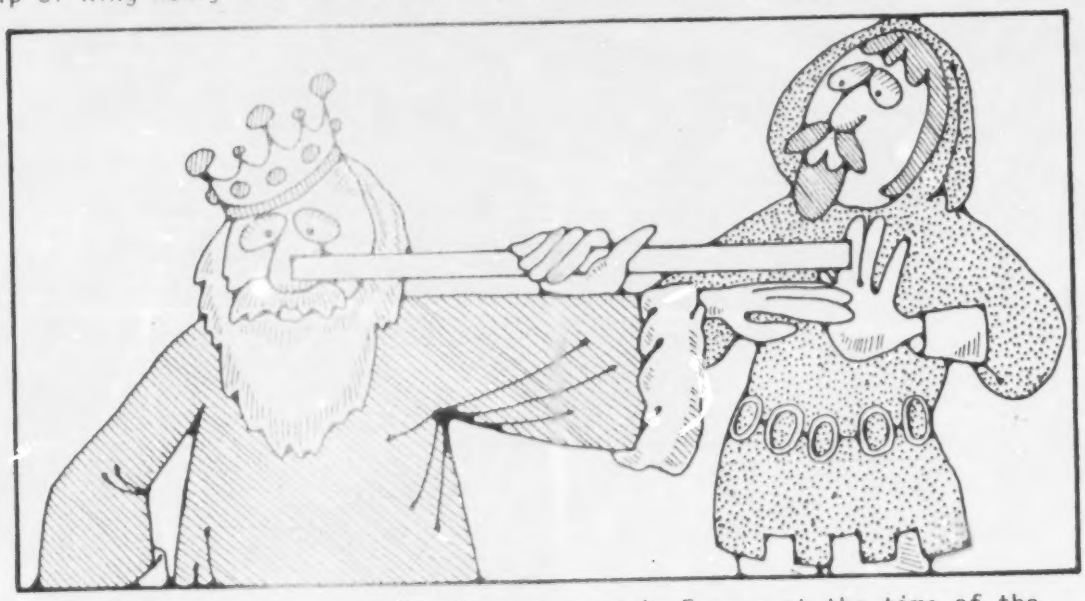
1000 whats? = _____

0.001 scent = _____

0.01 pede = _____

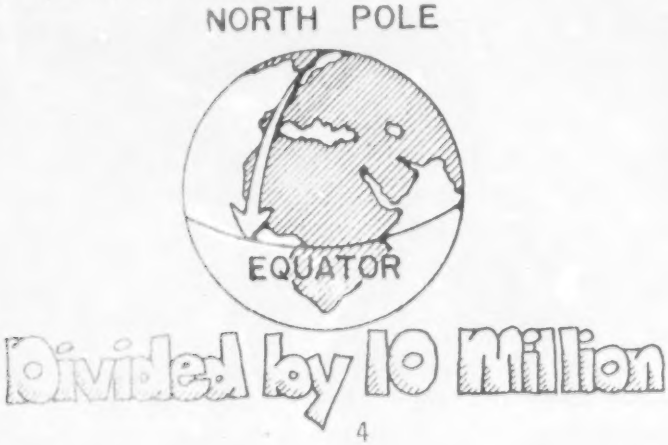
LESSON 4: A BRIEF HISTORY OF THE METRIC SYSTEM

Prior to 1790, the measurement systems of Europe were based on arbitrary objects: an inch was once defined to be the length of 3 kernels of barley corn placed end-to-end; a rod was the combined left feet of the first 16 men coming out of a specific church on Sunday morning; an acre was the amount of land a team of oxen could plow in one day; the yard was the distance from the tip of King Henry I's nose to the tip of his extended middle finger; etc.



A similar hodge-podge of units was used in France at the time of the French Revolution. In 1789, the French Academy of Sciences was requested by the National Assembly to devise a new measurement system. The French Revolution was underway, and because of the antiaristocratic attitude of the French people, a change to a system not based on dimensions of royal monarchs was highly acceptable to them.

In developing the metric system the French scientists had three major objectives. The first objective was to find a unit of length that was measurable and reproducible everywhere, and natural in the physical world. To meet this objective, the meter was defined to be one ten-millionth of the distance from the equator to the north pole.



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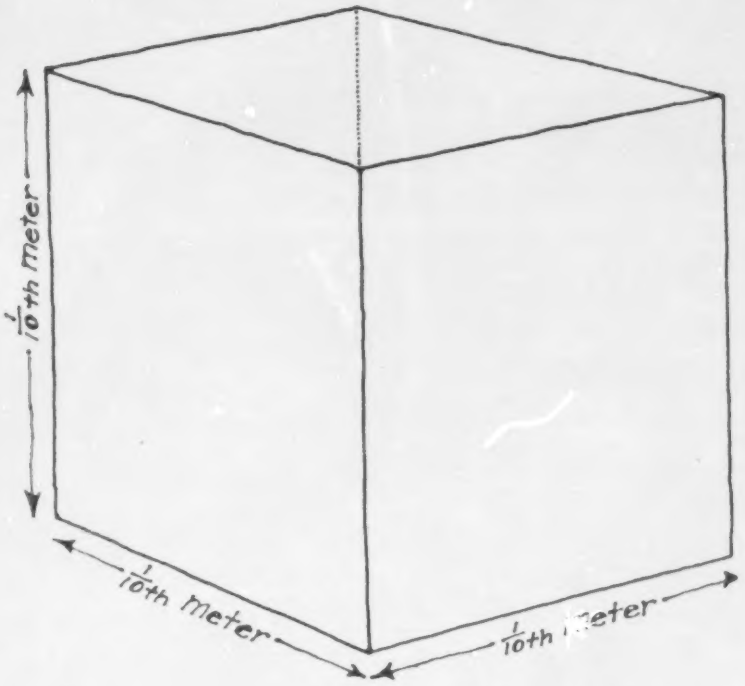
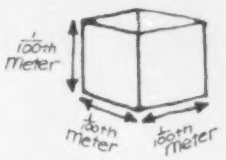
The second objective was to relate the unit of length to other units of measurement. For the main unit of capacity they selected a cube, with each of its sides equal to 1/10th of a meter (cubic decimeter), and called the amount of space contained within this box-shaped figure a "liter."



Liter

For the main unit of mass, the French scientists took a cube with each of its sides equal to 1/100th of a meter (a cubic centimeter), filled this box with pure water at 4° Centigrade, and designated the mass of this water as a "gram." Thus, the meter was used to define both the liter and gram.



Gram

The third objective was to simplify the conversion from one unit to another. We have already seen how a system of prefixes, which are powers of ten, was used to accomplish this objective. Since each metric unit is ten times larger than the next smaller unit, converting from one unit to another can be accomplished by merely moving a decimal point. Thus

35 meters =
- 0.035 kilometers
- 0.35 hectometers
- 3.5 dekameters
- 350 decimeters
- 3500 centimeters
- 35 000 millimeters

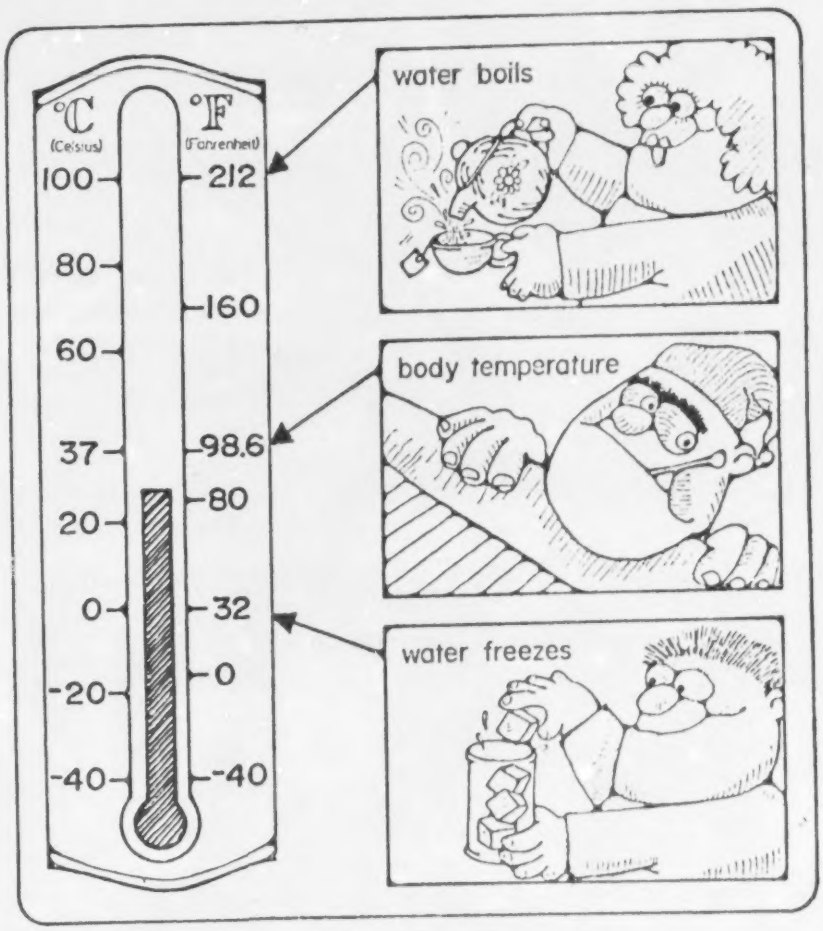
Scientists adopted the metric system immediately, for it made their work much simpler. Nations, on the other hand, have been slow to adopt it. It wasn't until 1840 that the French government made its use mandatory. By 1900, thirty-five nations had officially adopted it, and by the middle of this century, the main holdouts were the English-speaking nations. In 1965, England joined the European Common Market. Since Europe used the metric system, England decided to go metric. The other English-speaking nations soon followed. Ten years later, President Ford signed the Metric Conversion Act of 1975. Finally, after 180 years, the conversion to metric is nearing completion.

LESSON 5: TEMPERATURE

There is one more metric unit which is encountered in daily living, the unit for temperature, degree Celsius (pronounced sell-see-us). Most adults are surprised to learn that "degree Centigrade," which they vaguely remember from their school days, has been changed to "degree Celsius."

The change came about in 1948, at the General Conference on Weights and Measures which convenes periodically to review and ratify measurement standards. A debate arose concerning the name of a unit for metric temperature. Some conferees favored the English "degree Centigrade," and others favored the French "degré centisimal". By coincidence, the centigrade scale had been invented by Anders Celsius. Since his last name started with "C," his name was selected as a compromise.

The Celsius scale is simpler than the Fahrenheit scale. The drawing below illustrates its simplicity. Water boils at 100°C and freezes at 0°C. If you can remember the four temperatures shown on the thermometer, you'll have a good beginning on making sense of the Celsius scale.



LESSON 6: MASS (WEIGHT?)

The purpose of this lesson is to explain the difference between mass and weight. The kilogram is the unit of mass, and the Newton (after Sir Isaac Newton) is the unit of weight.

If you were an astronaut in outer space, the objects in your space craft would have very little weight. If you held a bowling ball in your hand and released it, it wouldn't fall. It would remain suspended in space. If the bowling ball were placed on a scale, it would read zero. It would be weightless. Why? Because the bowling ball is so far from the earth that it has escaped the pull of the earth's gravity.

Weight, then, is a measure of gravitational pull on an object. The weight of an object can vary, depending on where it is in the universe.

The mass of an object never varies. It is the same on earth as anywhere else in the universe. Mass is a measure of how much matter an object contains. The bowling ball is weightless in space, but it still has the same mass. Because of its mass, if you kicked it with your bare foot it would still hurt, whether you were on earth or in a spaceship.

We determine the weight of an object by spring scales which measure the downward pull on an object placed on it. This downward force is measured in Newtons. The mass of an object, on the other hand, is determined by using a balance: the object is placed on one side and balanced with standardized mass pieces. This is what a pharmacist does when he mixes a compound.

However, the mass of an object is directly proportional to its weight on earth. That is, a one-kilogram mass has a weight of about 9.8 Newtons at sea level; a two-kilogram mass has a weight of about 19.6 Newtons; etc. Thus, either mass or weight gives us a good measure of how much matter an object contains. Therefore, in everyday usage spring scales are used for determining mass in kilograms because it is much more convenient than using a balance. The 4M COMPANY uses the words interchangeably - mass (weight). For everyday usage, the distinction is unimportant.

LESSON 7: SI

The French scientists made several errors in their original calculations. For example, they miscalculated the distance from the equator to the north pole by about 2000 meters, and instead of being equal to one cubic decimeter, the liter was actually equal to 1.000028 cubic decimeters.

To correct these errors, various scientific organizations of the world met in 1960 to devise a modern metric system which is called the International System of Units (or SI for short, after the French Le Systéme Internationale d'Unités). SI was created to meet the exacting demands for precise scientific measurement. Most of the units and prefixes will not be used by the average citizen. But for the sake of completeness, we include a list of the base units and all the prefixes.

BASE UNITS

Quantity	Name	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

Two units not on the list above are commonly used with the metric system. Instead of referring to liquid capacity in terms of cubic decimeters, the liter is used. And instead of using the Kelvin for temperature, degree Celsius is used (the Kelvin scale was derived from the Celsius scale).

PREFIXES

Prefix	Symbol	Pronunciation Symbol	Multiples & Fractions
exa	E	ex´ah	1 000 000 000 000 000 000
peta	P	pet´ah	1 000 000 000 000 000
tera	T	tear´ah	1 000 000 000 000
giga	G	jig´,ah	1 000 000 000
mega	M	meg´ah	1 000 000
kilo	k	kill´oh	1 000
hecto	h	heck´toh	100
deka	da	deck´ah	10
deci	d	dess´ih	0.1
centi	c	cent´ih	0.01
milli	m	mill´ih	0.001
micro	u	mike´roh	0.000 001
nano	n	nan´oh	0.000 000 001
pico	p	pee´koh	0.000 000 000 001
femto	f	fem´toh	0.000 000 000 000 001
atto	a	att´oh	0.000 000 000 000 000 001

Complete these equations if you can:

1 000 000 lomania = _____

1 000 000 000 ntic = _____

0.000 001 nesia = _____

1 000 000 000 000 tory = _____

0.000 000 000 000 000 001 rney = _____

1 000 000 000 000 000 000 rcist = _____

LESSON 8: SI STYLE CONVENTIONS

Think of it! There is no universal language, there is no universal monetary system. But at last we stand on the threshold of having a universal measurement system, a system understood by people all over the world. To make communication easier, certain style conventions are recommended. This section cites the major conventions.

1. Use a space to separate large numbers into groups of three. Do not use a comma. In many countries a comma is recognized as a decimal point.

Example:	Correct	Incorrect
	600 300.6	600,300.6

2. Use a zero in front of the decimal point when the numerical value is a partial unit.

Example:	Correct	Incorrect
	0.6 mm	.5 mm

3. Use a decimal to express partial units. Avoid using fractions to express partial units.

Example:	Correct	Incorrect
	0.25 kg	1/4 kg

4. Use uppercase or lowercase letters as they are given in the table. All abbreviations or symbols are to be used in the singular form. Do not use periods after symbols unless they conclude a sentence.

Example:	Correct	Incorrect
	mm (millimeters)	mms or mm's
	cg	c.g.
	ℓ	ℓ.

5. Prefixes must be combined with units. In common usage "kilo" means kilogram. Such usage is not preferred.

6. Avoid mixing units.

Example:	Correct	Incorrect
	12.75 m	12 m 75 cm

7. Avoid using multiple prefixes.

Example:	Correct	Incorrect
	ps (picosecond)	μμs (micromicrosecond)

8. Avoid capitalization of unit names (except Celsius) unless they start a sentence. Listings should be lowercase.

Example: Correct - The base unit for mass is the kilogram.

Incorrect - The base unit for mass is the Kilogram.

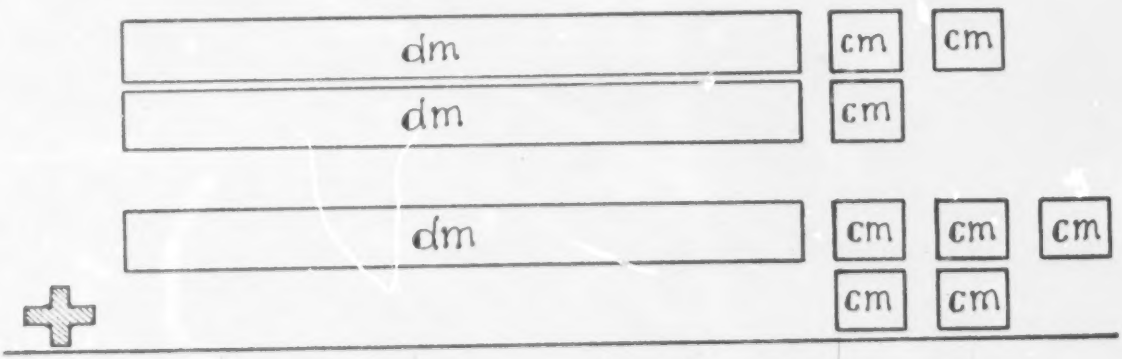
NEXT-TO-LAST-LESSON: DECIMALS

Our number system, our monetary system, and the metric system all share a common characteristic: they are decimal in nature. Because of this, the switch to metric makes the study of decimals even more important than ever. The 4M COMPANY begins the study of decimals in the third grade. The purpose of this lesson is to illustrate how the decimal nature of the metric system is used to teach decimals.

Since a decimeter is one-tenth of a meter, decimeters are used to introduce tenths. Students make a meter strip marked in tenths of meters and use it to measure various lengths.

Similarly, since a centimeter is one-hundredth of a meter, centimeters are used to introduce hundredths. And a millimeter, being one-thousandth of a meter, is used to introduce thousandths.

Addition and subtraction of decimals are explained in terms of metric units. Thus, the problem $\begin{array}{r} 0.23\ \text{m} \\ +0.15\ \text{m} \\ \hline \end{array}$ is represented as follows:



If placed end-to-end, these units would come to the 0.38 m mark on a meter marked in hundredths. Since 10 centimeters can be exchanged for 1 decimeter, borrowing and carrying are easily explained in terms of metric units. The students soon see that adding and subtracting decimals is very similar to adding and subtracting whole numbers.

LAST LESSON: METRIC FOR EVERYDAY LIVING

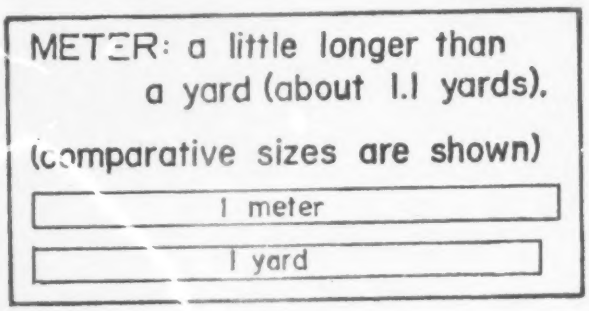
In this section we list those metric units which are most commonly used in everyday living.

Length: 1) A meter is a little longer than a yard.

2) A kilometer (1000 meters) is about 6/10th of a mile.

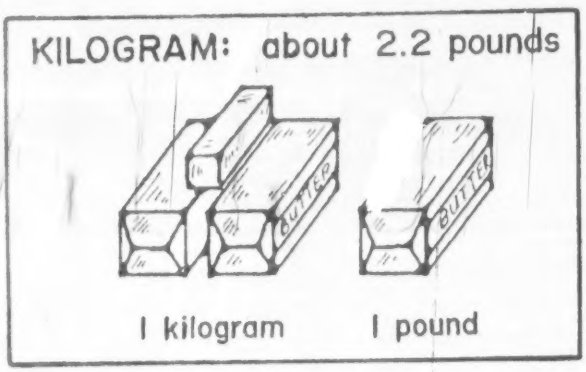
3) A centimeter (0.01 meter) is about the width of a paper clip.

4) A millimeter (0.001 meter) is about the thickness of a dime.



Capacity: 1) A liter is a little larger than a quart (about 1.06 quarts).

2) A milliliter is 1/5th of a teaspoon.



Mass: 1) A gram is the mass of two small thumb tacks.

2) A kilogram is about 2.2 pounds.

3) A metric ton is 2200 pounds.

4) A milligram is the weight of a bee's wing.

ANSWERS TO PROBLEMS

LESSON 3:

hectogram	deciliter
dekaliter	centiliter
kilometer	decigram
milligram	dekagram
hectoliter	dekacards
centigram	deciArnaz
millimeter	centimentalist
centimeter	kilomanjaros
milliliter	millitary
hectoliter	decimate
kiloliter	kilowhats?
kilogram	milliscent
dekameter	centipede
decimeter	

LESSON 7:

megalomania
jigantic
micronesia
teratory
attorney
exarcist